



**Joint Meeting of the Standing Committee on Emerging
Infectious Diseases and 21st Century Health Threats, the
Forum on Microbial Threats, and the Board on Global Health**

Expert Meeting on the Impact of Globalization on Future Health Crises

Friday, September 18, 2020 3:30 p.m. – 5:30 p.m. ET

[Virtual Zoom Meeting](#)





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AGENDA





Joint Meeting of the Standing Committee on Emerging Infectious Diseases and 21st Century Health Threats, the Forum on Microbial Threats, and the Board on Global Health

Agenda

Friday, September 18, 2020 3:30 p.m. – 5:30 p.m. ET
Virtual Zoom Meeting

Background: In response to a request from the Office of Science and Technology Policy (OSTP) and the Office of the Assistant Secretary for Preparedness and Response (ASPR), the National Academies of Sciences, Engineering, and Medicine established the Standing Committee on Emerging Infectious Diseases and 21st Century Health Threats. ASPR, in coordination with the Office of the Director of National Intelligence (ODNI) requested an expert meeting on the impact of globalization on future health crises. Given the expertise in both the Forum on Microbial Threats and the Board on Global Health in this topic, this meeting includes members of these bodies. Globalization has improved the world in many ways, but has also introduced fragility in supply chains, adversely affected the environment, witnessed the greatest number of refugees and internally displaced persons, expanded economic disparities, and increased the ability for novel pathogens to spread quickly around the globe. Factors such as extreme weather events and social and economic disruptions, including armed conflict, have also adversely affected global interdependence.

Meeting Objectives

Discuss and consider topics for further exploration on the following:

- What changes are associated with globalization that increase the probability of crises such as pandemics and other 21st century health threats?
- What are potential mitigating factors against these threats?
- How do these different factors interact and create risks of compound events or cascading effects?
- And is there any predictability of how this is changing in frequency or severity?

FRIDAY, SEPTEMBER 18, 2020

CLOSED SESSION

SESSION I

Welcoming Remarks and Sponsors' Description of Need

3:30 p.m.

Welcome and Charge to the Group

Harvey Fineberg, *Standing Committee Chair*
President
Gordon and Betty Moore Foundation

3:45 p.m. Sponsor Remarks

David (Chris) Hassell
Acting Principal Deputy Assistant Secretary
Senior Science Advisor
The Office of the Assistant Secretary for Preparedness and Response
U.S. Department of Health and Human Services

Kathryn Brinsfield
Senior Advisor
National Counterproliferation Center
Office of the Director of National Intelligence

4:00 p.m. Topic Introduction

Harvey Fineberg, *Standing Committee Chair*
President
Gordon and Betty Moore Foundation

Ann Kurth, *Board on Global Health Chair*
Dean and Professor
Yale University, School of Nursing

Peter Daszak, *Forum on Microbial Threats Chair*
President
EcoHealth Alliance

SESSION II **Group Discussions on the Challenges of:**

4:20 p.m. Prediction Modeling

Detection Assessment
Surveillance, monitoring, rapid threat assessment that is shared and accessible

Response
Preparedness, near term and focal, long-term and dispersed

5:15 p.m. Discussion of Next Steps with the Sponsors

Harvey Fineberg, *Committee Chair*
President
Gordon and Betty Moore Foundation

5:30 p.m. ADJOURN



LIST OF DISCUSSION TOPICS





Globalization and 21st Century Health Threats

List of Discussion Topics

Globalization has improved the world in many ways, but has also introduced fragility in supply chains, adversely affected the environment, witnessed the greatest number of refugees and internally displaced persons, expanded economic disparities, and increased the ability for novel pathogens to spread quickly around the globe. Factors such as extreme weather events and social and economic disruptions, including armed conflict, have also adversely affected global interdependence. What are the changes associated with globalization that increase the probability of crises such as pandemics and other infectious disease events? What are the potential mitigating factors against these threats? How do these different factors interact and create risks of compound events or cascading effects? Is there any predictability of how this is changing in frequency or impact?

Significant Factors Related to Increasing Incidence and Consequences of Severe Health Threats

- **Human dimensions:**
 - Increased trade and dependence on foreign supplies that can be disrupted when needed most
 - Local and regional migration patterns that can spread infectious diseases (e.g., Ebola in the DRC)
 - Increased refugees and internally displaced persons
 - Socio-cultural conflicts
 - Urbanization, including sanitation and crowding
 - Rapid population growth into areas unable to support it
 - Spread of misinformation
 - Asynchronous country policies on bioethics and future human health
 - Trends in armed conflict and terrorism
 - Antimicrobial resistance and the emergence of multi-drug resistant organisms
 - Travel that can rapidly spread pathogens
- **Environment:**
 - Extreme weather events enabling emergence of transboundary zoonotic disease
 - Floods, droughts, extreme heat and other impacts of extreme weather events
 - Thawing of the permafrost and resultant environmental and societal disruption
 - Decreased food and water security
- **One Health**
 - Increased intermingling between animals and humans
 - Animal farming practices, particularly surrounding pig products
 - Changing vector and reservoir host range
 - Wet markets and contact with wildlife

Economic and Technology Issues:

- o Effects of poverty on underlying health and healthcare access
- o Loss of industries and national/regional capabilities
- o Technology theft
- o Creation of new bioweapons technology



ROSTERS AND BIOS





**STANDING COMMITTEE ON EMERGING
INFECTIOUS DISEASES AND 21ST CENTURY
HEALTH THREATS**



The National Academies of **SCIENCES • ENGINEERING • MEDICINE**

Health and Medicine Division

Standing Committee on Emerging Infectious Diseases and 21st Century Health Threats

In response to a request from the Office of Science and Technology Policy (OSTP) and the Office of the Assistant Secretary for Preparedness and Response (ASPR), the National Academies of Sciences, Engineering, and Medicine will convene a standing committee of experts to help inform the federal government on critical science and policy issues related to emerging infectious diseases and other 21st century health threats. The standing committee will include members with expertise in emerging infectious diseases, public health, public health preparedness and response, biological sciences, clinical care and crisis standards of care, risk communication, epidemiology, and regulatory issues, as well as veterinary science, One Health, ethics, and community engagement. The standing committee will provide a venue for the exchange of ideas among federal government agencies, the private sector, and the academic community, as well as other relevant stakeholders.

The standing committee will:

- Stand ready to respond on short notice to requests from the federal government to assess and consider the science and policy implications of an emerging infectious disease or significant public health threat;
- Provide a venue to enable science and policy discussions relevant to the federal government on emerging issues, research, and activities through in-depth knowledge of the sponsor's programs, goals, and objectives;
- Identify opportunities to integrate science into national preparedness and response decision making;
- Explore lessons learned and best practices from previous preparedness and response efforts, and identify opportunities to disseminate that information to a variety of stakeholders;
- Serve as a focal point for national policy discussions by experts and other leaders in the field;
- Consider, identify, and discuss strategies for addressing misinformation; and

- Respond to the federal government's needs for continuing dialog related to strategic planning and program development to address emerging infectious diseases, biosecurity, and public health and medical preparedness.

At the request of the sponsors, the standing committee will be involved in the planning, development, and oversight of related ad hoc activities undertaken by separately appointed committees operating under its auspices.

The standing committee will serve as a focal point for the discussion of scientific, technical, and policy issues relevant to emerging infectious diseases and public health preparedness and response that warrant detailed examination. Topics for discussion with the standing committee may include:

- Technical assistance and/or assessment of response to emerging infectious diseases;
- Availability of and access to information, samples, and other materials to determine the origin and evolution of emerging infectious diseases;
- International coordination and engagement;
- Technical assessment of ecological and evolutionary drivers of disease emergence;
- Approaches to proactive public messaging and strategies to address misinformation;
- Other science and policy issues relevant to emerging infectious diseases and 21st century health threats.

The committee will carry out its charge at its in-person and virtual meetings by gathering evidence from experts, deliberating, and, when necessary, by preparing short reports.

COMMITTEE SPONSORS

HHS Office of Assistant Secretary for Preparedness and Response and Office of Science and Technology Policy

COMMITTEE ROSTER

Harvey Fineberg, M.D., Ph.D. (Chair)

President

Gordon and Betty Moore Foundation

Kristian Andersen, Ph.D.

Associate Professor and Director of Infectious
Disease Genomics, Scripps Research Translational
Institute

The Scripps Research Institute

Ralph Steven Baric, Ph.D.

William R. Kenan, Jr. Distinguished Professor
The University of North Carolina at Chapel Hill

Mary Bassett, M.D., M.P.H.

Director of the François-Xavier Bagnoud Center for
Health and Human Rights
Harvard School of Public Health

Trevor Bedford, Ph.D.

Associate Faculty Member, Vaccine and Infectious
Disease Division, Public Health Sciences Division,
and Human Biology Division
Fred Hutchinson Cancer Research Center

Georges Benjamin, M.D.

Executive Director

American Public Health Association

Donald Berwick, M.D., M.P.P., F.R.C.P, KBE

Lecturer of Health Care Policy
Harvard Medical School

Richard Besser, M.D.

President and CEO

Robert Wood Johnson Foundation

R. Alta Charo, J.D.

Warren P. Knowles Professor of Law and Bioethics
University of Wisconsin at Madison

Peter Daszak, Ph.D.

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Health Officer and Chief, Communicable Disease
Epidemiology & Immunization Section and
Professor in Medicine

Ellen Embrey

President/CEO

Stratitia, Inc.

Baruch Fischhoff, Ph.D.

Howard Heinz University Professor
Department of Engineering and Public Policy
Carnegie Mellon University

Diane Griffin, M.D., Ph.D.

Professor, Department of Molecular Microbiology
and Immunology
Johns Hopkins Bloomberg School of Public Health

Robert Groves, Ph.D., M.A.

Executive Vice President and Provost
Gerard J. Campbell, S.J. Professor
Math and Statistics Department and Sociology
Department
Georgetown University

Margaret Hamburg, M.D.

Foreign Secretary
National Academy of Medicine

Dan Hanfling, M.D.

Vice President, Technical Staff
In-Q-Tel

John Hick, M.D.

Associate Medical Director for EMS
Medical Director of Emergency Medicine
Hennepin County Medical Center

Kent E. Kester, M.D.

Vice President and Head, Translational Science and
Biomarkers
Sanofi Pasteur

Patricia King, J.D.

Professor Emerita

Georgetown University Law Center

Jonna Mazet, D.V.M., M.P.V.M., Ph.D.

Executive Director, One Health Institute
UC Davis School of Veterinary Medicine

Phyllis Meadows, Ph.D., M.S.N., R.N.

Senior Fellow, Health
The Kresge Foundation

Tara O'Toole, M.D., M.P.H.

Executive Vice President
In-Q-Tel

Alexandra Phelan, S.J.D., LL.M., LL.B.

Assistant Professor
Center for Global Health Science and Security
Georgetown University

David Relman, M.D.

Thomas C. and Joan M. Merigan Professor of
Medicine, and of Microbiology & Immunology;
Chief of Infectious Diseases
Stanford University; VA Palo Alto Health Care System

Mark Smolinski, M.D., M.P.H.

President
Ending Pandemics

David Walt, Ph.D.

Hansjörg Wyss Professor of Biologically Inspired
Engineering
Harvard Medical School

CONTACT INFORMATION

Andrew Pope, Ph.D.

Senior Director, Board on Health Sciences Policy
202-334-1739
apope@nas.edu

Lisa Brown, M.P.H.

Committee Director, Board on Health Sciences Policy
202-334-2487
lbrown@nas.edu

ADDITIONAL INFORMATION

For additional information, please visit
<https://www.nationalacademies.org/our-work/standing-committee-on-emerging-infectious-diseases-and-21st-century-health-threats>

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

Health and Medicine Division

Standing Committee on Emerging Infectious Diseases and 21st Century Health Threats

COMMITTEE MEMBER BIOSKETCHES

Harvey Fineberg, M.D., Ph.D. (Chair)

President

Gordon and Betty Moore Foundation

Harvey Fineberg is president of the Gordon and Betty Moore Foundation. He previously served as president of the Institute of Medicine from 2002 to 2014 and as provost of Harvard University from 1997 to 2001, following 13 years as dean of the Harvard School of Public Health. Fineberg devoted most of his academic career to the fields of health policy and medical decision-making. His past research has focused on the process of policy development and implementation, assessment of medical technology, evaluation and use of vaccines, and dissemination of medical innovations. Fineberg serves on the boards of the Carnegie Endowment for International Peace and the China Medical Board. He helped found and served as president of the Society for Medical Decision Making, previously served on and chaired the board of the William and Flora Hewlett Foundation, and chaired the committee to review the performance of the World Health Organization and the functioning of the International Health Regulations (2005) during the 2009 H1N1 influenza pandemic. Fineberg is co-author of the books *Clinical Decision Analysis*, *Innovators in Physician Education* and *The Epidemic That Never Was*, an analysis of the controversial federal immunization program against swine flu in 1976. He has co-edited several books on such diverse topics as AIDS prevention, vaccine safety, understanding risk in society and global health. He has also authored numerous articles published in professional journals. Fineberg chaired the National Academies committee that produced the 2019 report on *Reproducibility and Replicability in Science*. He earned his bachelor's and doctoral degrees at Harvard and is the recipient of several honorary degrees.

Kristian Andersen, Ph.D.

Associate Professor and Director of Infectious Disease Genomics, Scripps Research Translational Institute

The Scripps Research Institute

Kristian Andersen is an associate professor in the Department of Immunology and Microbiology at Scripps Research, with joint appointments in the Department of Integrative Structural and Computational Biology, and at the Scripps Research Translational Institute. Over the past decade, his research has focused on the complex relationship between host and pathogen. Using a combination of next-generation sequencing, field work, experimentation, and computational biology he has spearheaded large international collaborations investigating the emergence, spread and evolution of deadly pathogens, including SARS-CoV-2, Zika virus, Ebola virus, West Nile virus, and Lassa virus. His work is highly cross-disciplinary and exceptionally collaborative. Kristian earned his doctoral degree from the University of Cambridge and performed postdoctoral work in Pardis Sabeti's group at Harvard University and the Broad Institute.

Ralph Baric, Ph.D.

William R. Kenan, Jr. Distinguished Professor
The University of North Carolina at Chapel Hill

Ralph Baric is a William R. Kenan, Jr. Distinguished Professor in the Department of Epidemiology at the University of North Carolina. He obtained a Bachelor of Science Degree in Zoology from North Carolina State University in 1977 and a PhD in Microbiology and Immunology from North Carolina State University in 1983. He conducted postgraduate research at the University of Southern California School of Medicine in the department of Microbiology and Immunology between 1983-1986. He is a Harvey Weaver Scholar from the National Multiple Sclerosis Society and an Established Investigator Awardee from the American Heart Association. In addition, he is a World Technology Award Finalist, a fellow of the American Association for Microbiology, a senior editor of PLoS Pathogen, and a member of the editorial board of several other specialty journals. He was a member of the National Academy Sciences Working Groups that focused on Gene Sequence Methods for Classification of Select Agents and the Risks and Benefits of Gain of Function Research, an invited speaker to the Institute of Medicine Forum on Emerging Infectious Diseases and an invited panelist for the MERS-CoV Stakeholders Workshop. His group has published over 300 papers, many in highly visible journals like PNAS, Nature Medicine, Science, PLoS Medicine and PLoS Pathogens. The Baric laboratory uses genetic, immunologic, molecular and biochemical approaches to study the molecular mechanisms regulating virus replication, pathogenesis, molecular evolution and cross species transmission using emerging coronaviruses, flaviviruses (Dengue) and noroviruses as model systems. We have pioneered new strategies for developing reverse genetic approaches for manipulating the SARS-CoV, SAR-CoV-2 and MERS-CoV genomes and are actively studying the role of multiple genes that function in cross species transmission, virulence, pathogenesis, viral transcription and RNA fidelity. The Baric laboratory is also identifying key neutralizing epitopes in emerging coronaviruses, dengue and noroviruses using human monoclonal antibodies and structure guided immunogen design to develop broadly active vaccines and immunotherapeutics against these pathogens. Finally, his group has developed novel animal models of human disease and identified dozens of host susceptibility loci that regulate emerging CoV pathogenesis.

Mary Bassett, M.D., M.P.H.

Director of the François-Xavier Bagnoud Center for Health and Human Rights
Harvard School of Public Health

Mary Bassett is the Director of the FXB Center for Health and Human Rights at Harvard University, as well as the FXB Professor of the Practice of Health and Human Rights at the Harvard School of Public Health. With more than 30 years of experience in public health, Dr. Mary Travis Bassett has dedicated her career to advancing health equity. Prior to her directorship at the FXB Center, Dr. Bassett served for four years as commissioner of Health for New York City. As commissioner, she worked to ensure that every New York City neighborhood supported the health of its residents, with the goal of closing gaps in population health across the city. Originally from New York City, Dr. Bassett lived in Zimbabwe for nearly 20 years. Previously, she was the Program Director for the African Health Initiative and the Child Well-being Program at the Doris Duke Charitable Foundation. She received her B.A. in History and Science from Harvard University and her M.D. from Columbia University's College of Physicians and Surgeons. She served her medical residency at Harlem Hospital Center, and has a master's degree in Public Health from the University of Washington, where she was a Robert Wood Johnson Clinical Scholar.

Trevor Bedford, Ph.D.

Associate Faculty Member, Vaccine and Infectious Disease Division, Public Health Sciences Division,
and Human Biology Division
Fred Hutchinson Cancer Research Center

Trevor Bedford is currently Associate Member of the Vaccine and Infectious Disease Division, the Public Health Sciences Division, and the Human Biology Division at the Fred Hutchinson Cancer Research Center. Dr. Bedford uses powerful computers and complex statistical methods to study the rapid spread and evolution of viruses. Data gathered from these processes help researchers develop successful strategies for monitoring and controlling infectious diseases. His visual representations of viral family trees are used to show how the fate of dangerous outbreaks is often determined by the genetics of the infectious agent, human behavior and geography. Dr. Bedford has applied these techniques to document the worldwide spread of seasonal flu viruses. He is developing models to predict which strains of influenza are likely to be most challenging to humans — data that help inform the crucial early decisions about which strains to include in annual flu shots. He specializes in tracking the evolutionary changes of viruses such as HIV and influenza that use RNA, rather than DNA, to carry their genetic information. RNA viruses are much more prone to rapid mutation, which makes many of them particularly nimble at escaping the human immune system and difficult to stop with vaccines. He is a leading advocate for the immediate release of research analyzing viral evolution during epidemics, fresh information that could make a lifesaving difference. He received his Ph.D. in biology from Harvard University.

Georges Benjamin, M.D.

Executive Director
American Public Health Association

Georges Benjamin is well-known as a health leader, practitioner, and administrator. Dr. Benjamin has served as the executive director of the American Public Health Association, the nation's oldest and largest organization of public health professionals, since December 2002. He is a former secretary of Health for the state of Maryland. Dr. Benjamin is a graduate of the Illinois Institute of Technology and the University Of Illinois College Of Medicine. He is board-certified in internal medicine, a Master of the American College of Physicians, a fellow of the National Academy of Public Administration and a fellow emeritus of the American College of Emergency Physicians. He serves on several nonprofit boards such as Research!America, the University of Maryland Medical System and, the Reagan-Udall Foundation. He is a member of the National Academy of Medicine. In April 2016, President Obama appointed Benjamin to the National Infrastructure Advisory Council, a council that advises the president on how best to assure the security of the nation's critical infrastructure.

Donald Berwick, M.D., M.P.P., F.R.C.P., KBE

Lecturer of Health Care Policy
Harvard Medical School

Donald Berwick is president emeritus and senior fellow at the Institute for Healthcare Improvement and former administrator of the Centers for Medicare & Medicaid Services. A pediatrician by background, Dr. Berwick has served on the faculty of the Harvard Medical School and Harvard School of Public Health, and on the staffs of Boston's Children's Hospital Medical Center, Massachusetts General Hospital, and the Brigham and Women's Hospital. He has also served as vice chair of the US Preventive Services Task Force, the first "independent member" of the American Hospital Association Board of Trustees, and chair of the National Advisory Council of the Agency for Healthcare Research and Quality. He served two terms on the Institute of Medicine's (IOM's) Governing Council, was a member of the IOM's Global Health Board, and served on President Clinton's Advisory Commission on Consumer Protection and Quality in the Healthcare Industry. Recognized as a leading authority on health care quality and improvement, Dr. Berwick has received numerous awards for his contributions. In 2005, he was

appointed "Honorary Knight Commander of the British Empire" by Her Majesty, Queen Elizabeth II in recognition of his work with the British National Health Service. Dr. Berwick is the author or co-author of over 160 scientific articles and six books. He currently serves as lecturer in the Department of Health Care Policy at Harvard Medical School.

Richard Besser, M.D.

President and CEO

Robert Wood Johnson Foundation

Richard Besser is president and CEO of the Robert Wood Johnson Foundation (RWJF), a position he assumed in April 2017. Dr. Besser is the former acting director for the Centers for Disease Control and Prevention (CDC), and ABC News' former chief health and medical editor. At RWJF, Dr. Besser leads the largest private foundation in the country devoted solely to improving the nation's health. RWJF's work is focused on building a comprehensive Culture of Health that provides everyone in America with a fair and just opportunity to live the healthiest life possible. In Dr. Besser's role at ABC News, he provided medical analysis and reports for all ABC News programs and platforms. His weekly health chats on social media reached millions. Before joining ABC News in 2009, Dr. Besser worked as director of the Coordinating Office for Terrorism Preparedness and Emergency Response at the CDC. In that role, he was responsible for all the CDC's public health emergency preparedness and emergency response activities. He also served as acting director of the CDC from January to June 2009, during which time he led the CDC's response to the H1N1 influenza pandemic. He is a member of the National Academy of Medicine. He received the Surgeon General's Medallion for his leadership during the H1N1 response, and in 2011 he accepted the Dean's Medal for his contributions to public health from the Johns Hopkins Bloomberg School of Public Health. Dr. Besser received his Bachelor of Arts degree in economics from Williams College and medical degree from the University of Pennsylvania. He completed a residency and chief residency in pediatrics at Johns Hopkins University Hospital in Baltimore.

R. Alta Charo, J.D.

Warren P. Knowles Professor of Law and Bioethics

University of Wisconsin at Madison

R. Alta Charo is a member of the National Academy of Medicine and is the Warren P. Knowles Professor of Law and Bioethics at the University of Wisconsin at Madison (UW), where she is on the faculties of the law and medical schools. She teaches in the areas of bioethics, public health law and biotechnology policy and has served on UW's clinical ethics and research oversight committees. Professor Charo was a member of President Obama's transition team, focusing her attention particularly on transition issues related to NIH, FDA, stem cell policy, and women's reproductive health. From 2009 to 2011 she was on leave to serve as a senior policy advisor on emerging technology issues in the Office of the Commissioner at FDA. Her federal advisory committee service includes the 1994 NIH Human Embryo Research Panel and President Clinton's National Bioethics Advisory Commission (1996 to 2001). At the National Academies she co-chaired (with Richard Hynes) the committee on guidelines for embryonic stem cell research, and has been a member of its Board on Life Sciences, Board on Population Health and Public Health Practice, and Board on Health Sciences Policy.

Peter Daszak, Ph.D.

President and CEO

EcoHealth Alliance

Peter Daszak is President of EcoHealth Alliance, a US-based organization that conducts research and outreach programs on global health, conservation, and international development. Dr. Daszak's research has been instrumental in identifying and predicting the origins and impact of emerging diseases across the globe. He is one of the founders of the field of Conservation Medicine and has been instrumental in the

growth of EcoHealth, One Health, and now Planetary Health. Dr. Daszak is a member of the National Academy of Medicine and Chair of the NASEM's Forum on Microbial Threats. He is a member of the NRC Advisory Committee to the US Global Change Research Program, the Supervisory Board of the One Health Platform, the One Health Commission Council of Advisors, the CEEZAD External Advisory Board, the Cosmos Club, and the Advisory Council of the Bridge Collaborative. He has served on the IOM Committee on global surveillance for emerging zoonoses, the NRC committee on the future of veterinary research, the International Standing Advisory Board of the Australian Biosecurity CRC; and has advised the Director for Medical Preparedness Policy on the White House National Security Staff on global health issues. Dr. Daszak is a regular advisor to WHO on pathogen prioritization for R&D. He received his Ph.D. in parasitic infectious disease from the University of East London.

Jeffrey S. Duchin, M.D.

Health Officer and Chief, Communicable Disease Epidemiology & Immunization Section and Professor in Medicine

Public Health – Seattle & King County, WA and University of Washington, Seattle

Jeffrey Duchin is the Health Officer and the Chief of the Communicable Disease Epidemiology & Immunization Section for Public Health–Seattle & King County, Professor of Medicine in the Division of Infectious Diseases, and Adjunct Professor in the School of Public Health at the University of Washington, Seattle. Jeff currently serves on the Centers for Disease Control & Prevention's (CDC) Board of Scientific Counselors (Office of Infectious Diseases), the CDC's Advisory Committee on Immunization Practices and the Board of Directors for the Infectious Disease Society of America. Jeff has previously been a member of the National Academy of Medicine's (NAM) Forum on Microbial Threats and Forum on Medical and Public Health Preparedness, and the National Quality Forum's Adult Immunization Committee. Jeff received his medical degree from Rutgers Medical School and trained in internal medicine at Thomas Jefferson University Hospital, completed a fellowship in general internal medicine and emergency medicine at the Hospital of the University of Pennsylvania, and did his infectious disease subspecialty training at the University of Washington in Seattle. Jeff is a graduate of the CDC's Epidemic Intelligence Service (EIS) Officer training where he was assigned to the National Center for Infectious Diseases where he also completed the CDC's Preventive Medicine Residency program. Jeff worked for CDC as a medical epidemiologist in the Divisions of Tuberculosis Elimination and HIV/AIDS Special Studies Branch before assuming his current position. His peer review publications and research interests focus on communicable diseases of public health significance. For a complete listing of publications, please see PubMed.

Ellen Embrey

President/CEO

Stratitia, Inc.

Ellen Embrey is President/CEO of Stratitia, Inc., a consulting firm focused on developing meaningful and innovative strategies, and delivering supporting tools and partnerships to bring them successfully to life. Ms. Embrey brings deep expertise in health and medical issues, as well as a wealth of other experience gained during her extensive federal service. In her last federal role, she performed the duties of the Assistant Secretary of Defense for Health Affairs and the Director, TRICARE Management Activity during the presidential transition period in 2009-2010. From 2002 to 2009, Ms. Embrey was the Deputy Assistant Secretary of Defense for Force Health Protection and Readiness, leading significant changes in Department of Defense policies and programs affecting deployment and combat casualty medicine, health promotion and preventive medicine, medical readiness and public health emergency preparedness and response. For 9 months in 2001, Ms. Embrey performed the duties of Assistant Secretary of Defense for Reserve Affairs, shaping policies affecting the readiness and use of the National Guard and Reserve in both federal and state status. From 2000 to 2001, she served as Chief of Staff of that office, and from 1998 to 2001, as Deputy Assistant Secretary of Defense for Military Assistance to Civil Authorities,

developing policies that shaped the role of the National Guard and Reserve components in supporting homeland security, disaster preparedness, and national disaster response capabilities, including advising the president on such matters in the days and weeks following September 11, 2001. Between 1978 and 1997, Ms. Embrey served in senior-level policy analyst, budget analyst, program analyst, management analyst, and systems analyst positions in the Office of the Assistant Secretary of Defense for Reserve Affairs, the Defense Contract Audit Agency, and the Office of Personnel Management. Ms. Embrey was recognized with the Secretary of Defense's Distinguished Civilian Service Award in 2001 and 2004, and twice received the Meritorious Executive Presidential Rank Award in 2006 and 2009.

Baruch Fischhoff, Ph.D.

Howard Heinz University Professor, Department of Engineering and Public Policy
Carnegie Mellon University

Baruch Fischhoff is Howard Heinz University Professor, Department of Engineering and Public Policy and Institute for Politics and Strategy, Carnegie Mellon University (CMU). A graduate of the Detroit Public Schools, he holds a BS (mathematics, psychology) from Wayne State University and a PhD (psychology) from the Hebrew University of Jerusalem. He is a member of the National Academy of Sciences and of the National Academy of Medicine. He is past President of the Society for Judgment and Decision Making and of the Society for Risk Analysis. He has chaired the Food and Drug Administration Risk Communication Advisory Committee and been a member of the Eugene (Oregon) Commission on the Rights of Women, the Department of Homeland Security Science and Technology Advisory Committee and the Environmental Protection Agency Scientific Advisory Board, where he chaired the Homeland Security Advisory Committee. He has received the American Psychological Association (APA) Award for Distinguished Contribution to Psychology, CMU's Ryan Award for Teaching, an honorary Doctorate of Humanities from Lund University, and an Andrew Carnegie Fellowship. He is a Fellow of APA, the Association for Psychological Science, Society of Experimental Psychologists, and Society for Risk Analysis. His books include *Acceptable Risk*, *Risk: A Very Short Introduction*, *Judgment and Decision Making*, *A Two-State Solution in the Middle East*, *Counting Civilian Casualties*, and *Communicating Risks and Benefits*. He has co-chaired three National Academy Colloquia on the Science of Science Communication, as well as its committees on applying decision science to intelligence analysis and its committee on foundational science for cybersecurity.

Diane Griffin, M.D., Ph.D.

Professor, Department of Molecular Microbiology and Immunology
Johns Hopkins Bloomberg School of Public Health

Diane Griffin is University Distinguished Service Professor and Alfred and Jill Sommer Chair of the W. Harry Feinstone Department of Molecular Microbiology and Immunology at Johns Hopkins Bloomberg School of Public Health. Dr. Griffin is a virologist recognized for her work on the pathogenesis of viral infections. She is known particularly for her studies on measles and alphavirus encephalomyelitis that have delineated the role of the immune response in virus clearance, vaccine-induced protection from infection, tissue damage and immune suppression. Dr. Griffin was born in Iowa City, Iowa, and grew up in Oklahoma City. She graduated from Augustana College, Rock Island, Illinois with a degree in biology and from Stanford University School of Medicine in 1968 with a Ph.D. in immunology and M.D., followed by a residency in internal medicine. She was a postdoctoral fellow in virology and infectious diseases at Johns Hopkins University School of Medicine and joined the faculty in 1974. She has been president of the American Society for Virology and of the American Society for Microbiology and is a member of both the National Academy of Sciences and the National Academy of Medicine.

Robert Groves, Ph.D., M.A.

Executive Vice President and Provost

Gerard J. Campbell, S.J. Professor, Math and Statistics Department & Sociology Department
Georgetown University

Robert Groves is the Gerard J. Campbell, S.J. Professor in the Math and Statistics Department as well as the Sociology Department at Georgetown University where he has served as the Executive Vice President and Provost since 2012. Groves is a Social Statistician, who studies the Impact of Social Cognitive and Behavioral Influences on the quality of Statistical Information. His research has focused on the impact of mode of data collection on responses in sample surveys, the social and political influences on survey participation, the use of adaptive research designs to improve the cost and error properties of statistics, and public concerns about privacy affecting attitudes toward statistical agencies. He has authored or co-authored seven books and scores of peer-reviewed articles. His 1989 book, *Survey Errors and Survey Costs*, was named one of the 50 most influential books in survey research by the American Association of Public Opinion Research. His book, *Nonresponse in Household Interview Surveys*, with Mick Couper, received the 2008 AAPOR Book Award. His co-authored book, *Survey Nonresponse*, received the 2011 AAPOR Book Award. He served as the Director of the US Census Bureau between 2009-2012. Groves serves on several boards and advisory committees including the National Research Council Committee on National Statistics, Pew Research Center Board, the National Science Board, and the Federal Economic Statistics Advisory Committee. He is an elected member of the US National Academy of Sciences, of the National Academy of Medicine, of the American Academy of Arts and Sciences, and of the International Statistical Institute.

Margaret Hamburg, M.D.

Foreign Secretary

National Academy of Medicine

Margaret Hamburg is an internationally recognized leader in public health and medicine, and currently serves as foreign secretary of the National Academy of Medicine and chair of the NTI | bio Advisory Group. She is a former Commissioner of the U.S. Food and Drug Administration (FDA), having served for almost six years. As FDA Commissioner she was known for advancing regulatory science, streamlining and modernizing FDA's regulatory pathways, and globalization of the agency. Before joining FDA, Hamburg was founding vice president and senior scientist at the Nuclear Threat Initiative. Previous government positions include Assistant Secretary for Planning and Evaluation, U.S. Department of Health and Human Services, Health Commissioner for New York City, and Assistant Director of the National Institute of Allergy and Infectious Diseases, National Institutes of Health. She is President-elect of the American Association for the Advancement of Science (AAAS), as well as an elected member of the Council on Foreign Relations and the National Academy of Medicine. Hamburg currently sits on the boards of the Commonwealth Fund, the Simons Foundation, the Urban Institute, the Global Alliance for Vaccines and Immunization, the Parker Institute for Cancer Immunotherapy and the American Museum of Natural History. She is chair of the Joint Coordinating Group for the Coalition for Epidemic Preparedness and Innovation, and a member of the Harvard University Global Advisory Council, the Global Health Scientific Advisory Committee for the Gates Foundation, the Harvard Medical School Board of Fellows, and the World Dementia Council. Dr. Hamburg earned her B.A. from Harvard College, her M.D. from Harvard Medical School and completed her medical residency at Weill Cornell Medical Center. She is the recipient of multiple honorary degrees and numerous awards.

Dan Hanfling, M.D.

Vice President, Technical Staff
In-Q-Tel

Dan Hanfling is Vice President on the Technical Staff at In-Q-Tel, a non-governmental not-for-profit strategic investor focused on enabling technologies to support national security requirements. He is a board-certified emergency physician practicing at Inova Fairfax Hospital, northern Virginia's Level I trauma center, where he led emergency preparedness response efforts in the aftermath of the 9-11 attacks and the anthrax mailings. He participates as a Medical Team Manager for Virginia Task Force One, a FEMA- and USAID-sanctioned international urban search and rescue team and has deployed to numerous catastrophic disaster events, both domestic and international. Dr. Hanfling currently serves as the co-chair of the National Academies Forum on Medical and Public Health Preparedness and co-chaired the Institute of Medicine committees responsible for developing the work on "crisis standards of care". Dr. Hanfling is Clinical Professor of Emergency Medicine at George Washington University. He received an AB in political science from Duke University and was awarded his medical degree from Brown University. He completed an internship in internal medicine at the Miriam Hospital in Providence, Rhode Island, and an emergency medicine residency at George Washington/Georgetown University Hospitals.

John Hick, M.D.

Associate Medical Director for EMS
Medical Director of Emergency Medicine
Hennepin County Medical Center

John Hick is a faculty emergency physician at Hennepin Healthcare and a Professor of Emergency Medicine at the University of Minnesota. Dr. Hick serves as the deputy medical director for Hennepin County Emergency Medical Services and Medical Director for Emergency Preparedness at HCMC. He is also the Vice-Chair of the Clinical Council for Life Link III helicopter service and medical director for MN TF-1 state US&R team. He served the Minnesota Department of Health as the medical director for the Office of Emergency Preparedness until becoming an Advisor to the Director of OEM at ASPR/HHS where he is the lead editor for the TRACIE healthcare disaster preparedness website. He is the founder and past chair of the Minneapolis/St. Paul Metropolitan Hospital Compact, a 32-hospital mutual aid and planning group active since 2002. He is a national speaker on hospital preparedness issues and has published numerous papers dealing with hospital preparedness for contaminated casualties, personal protective equipment, crisis standards of care, and surge capacity and was honored to serve the Institute of Medicine on their Crisis Standards of Care projects as well as the Forum on Medical and Public Health Preparedness for Disasters and Emergencies. Dr. Hick holds an M.D. from the Mayo Medical School.

Kent E. Kester, M.D.

Vice President and Head, Translational Science and Biomarkers
Sanofi Pasteur

Kent Kester is currently Vice President and Head, Translational Science and Biomarkers at Sanofi Pasteur. In this capacity, Dr. Kester leads a team of over 200 research and clinical professionals in the US and France focused on the translational development of new vaccines. During a 24-year career in the US Army, he worked extensively in clinical vaccine development and led multiple research platforms at the Walter Reed Army Institute of Research, the U.S. Department of Defense's largest and most diverse biomedical research laboratory with a major emphasis on emerging infectious diseases, an institution he later led as its Commander/Director. His final military assignment was as the Associate Dean for Clinical Research in the School of Medicine at the Uniformed Services University of the Health Sciences (USUHS). During his military service, Dr. Kester was appointed as the lead policy advisor to the US Army Surgeon General in both Infectious Diseases and in Medical Research & Development. In these

capacities, he worked extensively in the interagency environment and developed a variety of Army and DoD medical policies related to infectious diseases, both clinical and research aspects. Dr. Kester holds an undergraduate degree from Bucknell University and an M.D. from Jefferson Medical College, completing his internship and residency in internal medicine at the University of Maryland and a research fellowship in infectious diseases at the Walter Reed Army Medical Center. Currently a member of the US Government Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (PACCARB) and the Department of Veterans Affairs Health Services Research & Development Service Merit Review Board, he previously chaired the Steering Committee of the NIAID/USUHS Infectious Disease Clinical Research Program, and has served as a member of the FDA Vaccines & Related Biologics Products Advisory Committee (VRBPAC), the NIAID Advisory Council, and the CDC Office of Infectious Diseases Board of Scientific Counselors. He is the Vice Chair of the National Academy of Medicine Forum on Microbial Threats. Board-certified in both internal medicine and infectious diseases, Dr. Kester holds faculty appointments at USUHS and the University of Maryland; and is a fellow of the American College of Physicians, the Royal College of Physicians of Edinburgh, the Infectious Disease Society of America, and the American Society of Tropical Medicine and Hygiene. He is a member of the clinical faculty at the University of Maryland Shock Trauma Center in Baltimore.

Patricia King, J.D.

Professor Emerita

Georgetown University Law Center

Patricia King is Professor of Law emeritus at Georgetown University Law Center and an Adjunct Professor in the Department of Health Policy and Management, School of Hygiene and Public Health at Johns Hopkins University. She is the co-author of Cases and Materials on Law, Science and Medicine. She is a member of the National Academy of Medicine, a member of the American Law Institute, a fellow of the Hastings Center and a faculty affiliate of Georgetown's Kennedy Institute of Ethics. Her scholarship focuses on race and genomics, racial disparities in health and reproductive health. Professor King has served on numerous national advisory bodies formed to address the ethical issues generated by developments in science and technology, including the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research (1974-78), which produced the seminal "Belmont Report," the President's Advisory Committee on Human Radiation Experiments (1994-95), the National Institutes of Health's Embryo Research Panel (co-chair for policy, 1994), the Ethics, Legal and Social Issues Working Group of the NIH's Human Genome Project (1989-95), and the NIH's Recombinant DNA Advisory Committee (1979-81). She has served on numerous boards and Institute of Medicine committees and is currently a member of the Board of Health Sciences Policy of the National Academies. She is also a Director of Mathematica an employee-owned company. She is a graduate of Wheaton College (Massachusetts) and has served as a Trustee and Chair of the Wheaton College Board of Trustees. In 2018 she was designated a Life Trustee by the Wheaton College Board. She graduated from Harvard Law School and is a past member of the Harvard Corporation the governing board of Harvard University. She has received honorary degrees from Wheaton College, Old Dominion University, and Harvard University.

Jonna Mazet, D.V.M., M.P.V.M., Ph.D.

Executive Director, One Health Institute

UC Davis School of Veterinary Medicine

Jonna Mazet, D.V.M., M.P.V.M., Ph.D., is a Professor of Epidemiology and Disease Ecology at the UC Davis School of Veterinary Medicine and Executive Director of the UC Davis One Health Institute. Her work focuses on global health problem solving for emerging infectious diseases and conservation challenges. She is active in international One Health education, service, and research programs, most notably in relation to disease transmission among wildlife, domestic animals, and people and the ecological drivers of disease emergence. Currently, Dr. Mazet is the Co-Director of the US Agency for

International Development's One Health Workforce – Next Generation, an \$85 million educational strengthening project to empower professionals in Central/East Africa and Southeast Asia to address complex health threats, including antimicrobial resistance and zoonotic diseases. She recently served as the Global Director of PREDICT Project, a greater than \$200 million viral emergence early warning project under USAID's Emerging Pandemic Threats Division. She was elected to the US National Academy of Medicine in 2013 in recognition of her successful and innovative approach to emerging environmental and global health threats and serves on the National Academies of Science, Engineering, and Medicine's Forum on Microbial Threats and chairs the Academies' One Health Action Collaborative.

Phyllis Meadows, Ph.D., M.S.N., R.N.

Senior Fellow, Health
The Kresge Foundation

Phyllis Meadows currently serves as the Senior Fellow and Program Advisor for the Kresge Foundation Health Team. In this role, she is responsible for supporting the health team in the development and implementation of investment opportunities within and across the Foundation's various programming areas. Her professional career includes leadership roles in philanthropy, academia, community health and governmental public health. She has previously served in the role of Associate Dean for Public Health Practice and Clinical Professor - Health, Management and Policy with the University of Michigan School of Public Health. She has led several initiatives to expand multi-disciplinary practice in communities, designing the University's first certification program on population health and health equity for medical residents. She is currently a Distinguished Towsley Policy Maker in Residence with the University of Michigan's Gerald Ford School of Public Policy. She has taught and developed graduate level and professional continuing education courses to address emerging health issues, including topics on health policy and public health leadership. Dr. Meadows has extensive experience in public health practice having served in various leadership roles in public health. She has held several official appointments in public health leadership at the state, county and local levels. In her most recent appointment, she served as the Chief Health Officer and Director of Health for the City of Detroit, providing leadership for the department of health, environmental health, infectious diseases, child health, clinical and dental services for the residents of Detroit. Her philanthropic experience includes positions as Program Director for the W.K. Kellogg Foundation - Youth, Education and Higher Education; and advisor for several national initiatives of the Robert Wood Johnson Foundation including the Nurse Executive Leadership Program, Partners in Nursing, and the County Roadmaps project. As a registered nurse, she has worked in both community-based health and hospitals. She currently serves as a Board Member and Advisor for several state level organizations and private foundations focusing on health.

Tara O'Toole, M.D., M.P.H.

Executive Vice President
In-Q-Tel

Tara O'Toole currently serves as Executive Vice President at In-Q-Tel. Dr. O'Toole was confirmed as the Under Secretary for Science and Technology (S&T) at the U.S. Department of Homeland Security (DHS) and served from November 4, 2009 to September 23, 2013. From 2003 to November 2009, Dr. O'Toole was the CEO and Director of the Center for Biosecurity at the University of Pittsburgh Medical Center (UPMC), and Professor of Medicine and of Public Health at the University of Pittsburgh. The Center for Biosecurity of UPMC is an independent organization dedicated to improving the country's resilience to major biological threats. Dr. O'Toole is internationally known for her work on biosecurity and on health and safety issues related to the U.S. nuclear weapons complex. Her publications in the biodefense field include articles on the response to anthrax, smallpox, and plague biological attacks; containment of contagious disease epidemics; biodefense research and development strategies; and hospital preparedness. She is the founding editor of the journal Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science. She was a principal author and producer of Dark Winter, an influential exercise conducted in

June 2001 to alert national leaders to the dangers of bioterrorist attacks. She was also a principal writer and producer of Atlantic Storm, an international ministerial-level biosecurity exercise held in January 2005. Prior to founding the UPMC in 2003, Dr. O'Toole was one of the original members of the Johns Hopkins Center for Civilian Biodefense Strategies and served as its director from 2001 to 2003. She has served on numerous government and expert advisory committees dealing with biodefense, including panels of the Defense Science Board; the National Academy of Engineering Committee on Combating Terrorism; and the National Academy of Sciences Working Group on Biological Weapons. She served as chair of the Board of the Federation of American Scientists from 2006 to 2007, and in 2006 she was appointed to the board of Google Foundation's International Networked System for Total Early Disease Detection. From 1993 to 1997, Dr. O'Toole served as Assistant Secretary of Energy for Environment Safety and Health. In this position, she was the principal advisor to the Secretary of Energy on environmental protection and on the health and safety of the approximately 100,000 workers in the U.S. nuclear weapons complex and Department of Energy (DOE) laboratories. She developed the first overall management and safety plan for dealing with the highly enriched uranium, plutonium, spent fuel, and radioactive waste left in place when nuclear weapons production was stopped in the early 1990s. She ran the multi-agency, multimillion-dollar task force that oversaw the government's investigations into human radiation experiments conducted during the Cold War and led the U.S. delegation to Russia to establish the U.S./Russia cooperative effort to study radiation exposure and environmental hazards of the Russian nuclear weapons complex. Prior to her work at DOE, Dr. O'Toole was a senior analyst at the Congressional Office of Technology Assessment, where she directed several projects and studies, including the health impact of pollution resulting from nuclear weapons production. She also served as a consultant to industry and government in matters related to occupational and environmental health; worker participation in workplace safety protection; and organizational change. Dr. O'Toole practiced general internal medicine in community health centers in Baltimore from 1984 to 1988. She is board certified in internal medicine and occupational and environmental health. She has a bachelor's degree from Vassar College, an M.D. from the George Washington University, and a Master of Public Health degree from Johns Hopkins University. She completed internal medicine residency training at Yale University and a fellowship in Occupational and Environmental Medicine at Johns Hopkins University.

Alexandra Phelan, S.J.D., LL.M., LL.B.

Assistant Professor
Center for Global Health Science and Security
Georgetown University

Alexandra Phelan is an Assistant Professor at the Center for Global Health Science and Security in the Department of Microbiology and Immunology at Georgetown University School of Medicine. Dr. Phelan also holds an appointment as Adjunct Professor of Law at Georgetown University Law Center. Dr. Phelan works on legal and policy issues related to infectious diseases, with a particular focus on emerging and reemerging infectious disease outbreaks and international law. She has worked as a consultant for the World Health Organization, the World Bank, and Gavi: the vaccine alliance, and has advised on matters including international law and pathogen sharing, human rights law and Zika, intellectual property law, and contract law. She previously worked for a number of years as a solicitor at a firm in Melbourne, Australia and was admitted to practice to the Supreme Court of Victoria and High Court of Australia in 2010. Dr. Phelan's doctorate examined how overlap between fields of international law – in particular, global health law, international human rights law, and international environmental law – can serve as the catalyst to progressively develop international law to prevent and respond to infectious diseases. She also holds a Master of Laws, specializing in international law, from the Australian National University and a Bachelor of Biomedical Science/Bachelor of Laws (Honours) double degree from Monash University. She also holds a Diploma of Languages (Mandarin Chinese). Dr. Phelan is a General Sir John Monash Scholar and was recognized as an Associate Fellow of the Royal Commonwealth Society in 2015 for her human rights advocacy during the 2013-16 Ebola outbreak.

David Relman, M.D.

Thomas C. and Joan M. Merigan Professor in Medicine, and Chief of Infectious Diseases
Stanford University; VA Palo Alto Health Care System

David Relman is the Thomas C. and Joan M. Merigan Professor in Medicine, and Microbiology and Immunology at Stanford University, and Chief of Infectious Diseases at the Veterans Affairs Palo Alto Health Care System. Dr. Relman is also Senior Fellow at the Freeman Spogli Institute for International Studies (FSI), and served as Science Co-Director at the Center for International Security and Cooperation (2013-2017), at Stanford. He is currently director of a new Biosecurity Initiative at FSI. Relman trained at MIT and then Harvard Medical School, followed by clinical training in internal medicine and infectious diseases at the Massachusetts General Hospital in Boston, and then a postdoctoral fellowship in microbiology at Stanford. His early research focused on molecular methods for pathogen discovery and over the past 20 years, on the human microbiome. He was elected to the National Academy of Medicine in 2011. Dr. Relman served as vice-chair of the National Research Council Committee that reviewed the science performed for the FBI 2001 Anthrax Letters investigation, chair of the Forum on Microbial Threats (2007-2017), and is currently a member of the Intelligence Community Studies Board (2016-) as well as Chair of a Standing Committee tasked with examining the health-related problems of US embassy personnel stationed overseas, all at the U.S. National Academies of Science. He was a founding member of the National Science Advisory Board on Biosecurity (2005-2014), a member of the Working Group on Biodefense for the President's Council of Advisors on Science and Technology (The White House) (2016), and served as President of the Infectious Diseases Society of America (2012-2013). He holds an M.D. from Harvard Medical School.

Mark Smolinski, M.D., M.P.H.

President
Ending Pandemics

Mark Smolinski currently serves as President of Ending Pandemics. Dr. Smolinski brings 25 years of experience in applying innovative solutions to improve disease prevention, response, and control across the globe. Mark is leading a well-knit team—bringing together technologists; human, animal, and environmental health experts; and key community stakeholders to co-create tools for early detection, advanced warning, and prevention of pandemic threats. Since 2009, Mark has served as the Chief Medical Officer and Director of Global Health at the Skoll Global Threats Fund (SGTF), where he developed the Ending Pandemics in Our Lifetime Initiative in 2012. His work at SGTF created a solid foundation for the work of Ending Pandemics, which branched out as an independent entity on January 1, 2018. Prior to SGTF, Mark developed the Predict and Prevent Initiative at Google.org, as part of the starting team at Google's philanthropic arm. Working with a team of engineers, Google Flu Trends (a project that had tremendous impact on the use of big data for disease surveillance) was created in partnership with the U.S. Centers for Disease Control. Mark has served as Vice President for Biological Programs at the Nuclear Threat Initiative, a public charity directed by CNN founder Ted Turner and former U.S. Senator Sam Nunn. Before NTI, he led an 18-member expert committee of the National Academy of Medicine on the 2003 landmark report "Microbial Threats to Health: Emergence, Detection, and Response." Mark served as the sixth Luther Terry Fellow in Washington, D.C., in the Office of the U.S. Surgeon General and as an Epidemic Intelligence Officer with the U.S. Centers for Disease Control and Prevention. Mark received his B.S. in Biology and M.D. from the University of Michigan in Ann Arbor. He is board-certified in preventive medicine and public health and holds an M.P.H. from the University of Arizona.

David Walt, Ph.D.

Hansjörg Wyss Professor of Biologically Inspired Engineering
Harvard Medical School

David R. Walt is the Hansjörg Wyss Professor of Bioinspired Engineering at Harvard Medical School and Professor of Pathology at Harvard Medical School and Brigham and Women's Hospital, is a Core Faculty Member of the Wyss Institute at Harvard University and is a Howard Hughes Medical Institute Professor. Previously, he was University Professor at Tufts University. His laboratory pioneered the development of microwell arrays, which revolutionized the field of genetic analysis. Dr. Walt's laboratory also introduced the idea of digital protein detection by developing a high throughput technology for performing single molecule analysis. Dr. Walt's research is aimed at applying new technologies to address unmet clinical diagnostics needs. Dr. Walt is the Scientific Founder of Illumina Inc., Quanterix Corp., and has co-founded several other life sciences startups including Ultivue, Inc., Arbor Biotechnologies, Sherlock Biosciences, and Vizgen, Inc. He has received numerous national and international awards and honors for his fundamental and applied work in the field of optical microwell arrays and single molecules. He is a member of the National Academy of Engineering, the National Academy of Medicine, a Fellow of the American Academy of Arts and Sciences, a Fellow of the American Institute for Medical and Biological Engineering, a Fellow of the National Academy of Inventors, and is inducted in the US National Inventors Hall of Fame.



FORUM ON MICROBIAL THREATS



FORUM ON MICROBIAL THREATS
BOARD ON GLOBAL HEALTH
HEALTH AND MEDICINE DIVISION
THE NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE

The Forum on Microbial Threats was created in 1996 to provide a structured opportunity for discussion and scrutiny of critical—and possibly contentious—scientific and policy issues related to research on and the prevention, detection, surveillance, and responses to emerging, reemerging, and novel infectious diseases in humans, plants, and animals as well as the microbiome in health and disease. Since its creation the topics and issues that have been examined and discussed by the Forum continue to be of major global public health importance. Through public debate and private consultation, the activities of the Forum strive to facilitate discussion and inquiry into the most challenging and cross-cutting sets of challenges within and across the spectrum of “microbial threats.”

Activities of the Forum are designed to examine emerging as well as long-standing challenges in microbial ecology in “health” and “disease.” The Forum has been instrumental in changing the infectious disease paradigm from “the only good ‘bug’ is a dead ‘bug’” to a more ecologically-informed view of the beneficial contributions of the microbiome in health maintenance and how these microbial communities influence and are influenced by their environmental context. The summary reports of Forum workshops have highlighted and often anticipated some of the most important infectious disease issues of the past decade, including the challenge of emerging fungal diseases and the persistent problem of antimicrobial resistance. Through dissemination to public leaders, private industry, and policymakers, these summary reports have served as useful and timely educational resources and records of these public discussions and deliberations.

Today, the complexities and challenges posed by vector and non-vector borne diseases and the corresponding trends that contribute to their emergence and reemergence continue to confound the world’s public health, scientific, medical, pharmaceutical, and policymaking communities. The global vulnerability of human, plant, and animal populations has been increasingly recognized as a challenge not only to personal health, but also to public safety, economic stability and development, and national and international security. The realities of the unrelenting resurgence of once manageable diseases, the emergence of multidrug resistant infectious diseases, the emergence and spread of newly identified pathogens such as Middle East Respiratory Syndrome (MERS), the global challenge of multi-drug resistant microorganisms, the reemergence of vector-borne disease as a major, global, public health concern, and the emergence of the first global influenza pandemic of the 21st century—H1N1—serve as timely reminders of the continuing evolution and adaptation of infectious diseases and their attendant impacts on human, plant, and animal health—domestically and internationally. The activities of the Forum continue to track and anticipate these evolving challenges.

As a result of such cross-sector dialogue, priority issues for infectious disease research and public health policy have been recognized; critical issues warranting further investigation have been identified; and there have been increased opportunities for more effective collaborations and dialogue between the private and public sectors represented on the Forum, as well as between the medical, veterinary, and plant disease communities. The Forum’s membership consists of individuals from a wide range of disciplines and organizations in the public and private sectors, including the public health, medical, pharmaceutical, veterinarian, academic science, agricultural, and environmental communities.

Please see the next page for a list of the Forum’s current members.

FORUM MEMBERSHIP

CHAIR

Peter Daszak, Ph.D.

President
EcoHealth Alliance
New York, NY

Andrew Clements, Ph.D.

Deputy Director, Pandemic Influenza and Other
Emerging Threats Unit
U.S. Agency for International Development
Washington, DC

VICE CHAIR

Kent E. Kester, M.D.

Vice President and Head
Translational Science and Biomarkers
Sanofi Pasteur
Swiftwater, PA

Marcos A. Espinal, M.D., Dr.P.H., M.P.H.

Director, Communicable Diseases and
Environmental Determinants of Health
Pan American Health Organization
Washington, DC

Rima F. Khabbaz, M.D.

Director, National Center for Emerging and
Zoonotic Infectious Diseases
U.S. Centers for Disease Control and Prevention
Atlanta, GA

Eva Harris, Ph.D.

Professor, Division of Infectious Diseases and
Vaccinology
Director, Center of Global Public Health
University of California, Berkeley
Berkeley, CA

MEMBERS

Kevin Anderson, Ph.D.

Senior Program Manager
Science and Technology Directorate
Department of Homeland Security
Washington, DC

Elizabeth D. Hermsen, Pharm.D., M.B.A.

Head, Global Antimicrobial Stewardship
Merck & Co., Inc.
Omaha, NE

Timothy Burgess, M.D., M.P.H.

Director, Infectious Diseases Clinical Research
Program
Uniformed Services University of Health Sciences
Bethesda, MD

Christopher Houchens, Ph.D.

Director, Division of CBRN Countermeasures
BARDA
Deputy Assistant Secretary for Preparedness and
Response
U.S. Department of Health & Human Services
Washington, DC

Attending for Dr. Burgess:

Bernard Okech, Ph.D., M.S., M.P.H.

*Deputy Director, MPH Program
Uniformed Services University of Health Sciences
Bethesda, MD*

Chandy C. John, M.D., M.S.

Past President, American Society of Tropical
Medicine & Hygiene
Director, Ryan White Center for Pediatric Infectious
Diseases and Global Health
Indiana University School of Medicine

Cristina Cassetti, Ph.D.

Deputy Division Director, Division of Microbial and
Infectious Diseases
U.S. National Institute of Allergy and Infectious
Diseases
National Institutes of Health
Rockville, MD

Michael Mair, M.P.H.

Acting Director
Office of Counterterrorism and Emerging Threats
U.S. Food and Drug Administration
Silver Spring, MD

Jonna Mazet, D.V.M., M.P.V.M., Ph.D.

Professor of Epidemiology and Disease Ecology
Executive Director, One Health Institute

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School of Veterinary Medicine
University of California, Davis
Davis, CA

Sally A. Miller, Ph.D.

Distinguished Professor of Food, Agricultural and
Environmental Sciences
Department of Plant Pathology
The Ohio State University
Wooster, OH

Suerie Moon, Ph.D., M.P.A.

Director of Research, Global Health Centre
The Graduate Institute of International and
Development Studies, Geneva
Geneva, Switzerland

David Nabarro, B.M.B.Ch., M.Sc.

Advisor, Health and Sustainability
4SD – Skills, Systems, and Synergies for Sustainable
Development
Geneva, Switzerland

Rafael Obregon, Ph.D., M.A.

Chief of Communication for Development
United Nations Children's Fund
New York, NY

Kumanan Rasanathan, M.B.Ch.B., M.P.H.

Incident Manager, COVID-19
Coordinator, Health Systems (HSD)
World Health Organization
Phnom Penh, Cambodia

Gary A. Roselle, M.D.

Chief of Medical Service, Veterans Affairs Medical
Center
Director, National Infectious Disease Services
Veterans Health Administration
Cincinnati, OH

Peter A. Sands, M.P.A.

Executive Director
The Global Fund to Fight AIDS, Tuberculosis, and
Malaria
London, UK

Thomas W. Scott, Ph.D.

Distinguished Professor
Department of Entomology and Nematology

University of California, Davis
Davis, CA

Alan Tennenberg, M.D., M.P.H.

Chief Medical Officer
Johnson & Johnson Global Public Health
Jerusalem, Israel

Matthew Zahn, M.D.

Medical Director, Division of Epidemiology and
Assessment
Orange County Health Care Agency
Santa Ana, CA

STAFF

Julie Pavlin, M.D., Ph.D., M.P.H.

Director, Board on Global Health
Director, Forum on Microbial Threats
The National Academies of Sciences, Engineering,
and Medicine
Washington, DC

Julie Liao, Ph.D.

Associate Program Officer
Board on Global Health
The National Academies of Sciences, Engineering,
and Medicine
Washington, DC

Charles Minicucci

Senior Program Assistant
Board on Global Health
The National Academies of Sciences, Engineering,
and Medicine
Washington, DC

The National Academies of SCIENCES • ENGINEERING • MEDICINE

Members of the Forum on Microbial Threats BIOGRAPHIES



Forum Chair

Peter Daszak, Ph.D., is president of EcoHealth Alliance, a U.S.-based organization that conducts research and outreach programs on global health, conservation, and international development. Dr. Daszak's research has been instrumental in identifying and predicting the impact of emerging diseases across the globe. His achievements include identifying the bat origin of SARS, identifying the underlying drivers of Nipah and Hendra virus emergence, producing the first ever global

emerging disease 'hotspots' map, developing a strategy to find out how many unknown viruses exist that could threaten to become pandemic, identifying the first case of a species extinction due to disease, and discovering the disease chytridiomycosis as the cause global amphibian declines. Dr. Daszak is a member and chair-elect of the National Academy of Sciences, Engineering and Medicine's Forum on Microbial Threats. He is a member of the National Research Council (NRC) Advisory Committee to the U.S. Global Change Research Program, the Supervisory Board of the One Health Platform, the One Health Commission Council of Advisors, the Center of Excellence for Emerging and Zoonotic Animal Diseases External Advisory Board, the Cosmos Club, and the Advisory Council of the Bridge Collaborative; he has served on the Institute of Medicine committee on global surveillance for emerging zoonoses, the NRC committee on the future of veterinary research, the International Standing Advisory Board of the Australian Biosecurity Cooperative Research Centres, and has advised the Director for Medical Preparedness Policy on the White House National Security Staff on global health issues. Dr. Daszak is a regular advisor to the World Health Organization (WHO), World Organisation for Animal Health, and the Food and Agriculture Organization of the United Nations, and is actively involved in the WHO Expert group on Public Health Emergency Disease Prioritization. Dr. Daszak won the 2000 Commonwealth Scientific and Industrial Research Organisation medal for collaborative research on the discovery of amphibian chytridiomycosis, is the EHA institutional lead for USAID-EPT-PREDICT, is on the editorial boards of *Conservation Biology*, *One Health*, and *Transactions of the Royal Society of Tropical Medicine & Hygiene*, and is editor-in-chief of the journal *EcoHealth*. He has authored over 300 scientific papers, and his work has been the focus of extensive media coverage, ranging from popular press articles to television appearances.

Forum Vice Chair

Kent E. Kester, M.D., is currently vice president and head of Translational Science and Biomarkers at Sanofi Pasteur. During a 24-year career in the U.S. Army, he worked extensively in clinical vaccine development and led multiple research platforms at the Walter Reed Army Institute of Research, the U.S. Department of Defense's largest and most diverse biomedical research laboratory—an institution he later led as its commander/director. His final military assignment was as the associate dean for clinical research in the School of Medicine at the Uniformed Services University of the Health Sciences (USUHS). Dr. Kester holds an undergraduate degree from Bucknell University and an M.D. from Jefferson Medical College. He completed his internship and residency in internal medicine at the University of Maryland and a fellowship in infectious diseases at the Walter Reed Army Medical Center. A malaria vaccine researcher with over 70 scientific manuscripts and book chapters, Dr. Kester has played a major role in the development of the malaria vaccine candidate known as RTS,S. Currently



a member of the U.S. Government Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria, he previously chaired the Steering Committee of the National Institute of Allergy and Infectious Diseases (NIAID)-USUHS Infectious Disease Clinical Research Program, and has served as a member of the Food and Drug Administration's Vaccines and Related Biologics Products Advisory Committee, the NIAID Advisory Council, and the U.S. Centers for Disease Control's Office of Infectious Diseases Board of Scientific Counselors. Board certified in both internal medicine and infectious diseases, he holds faculty appointments at USUHS and the University of Maryland; and is a fellow of the American College of Physicians, the Infectious Diseases Society of America, and the American Society of Tropical Medicine and Hygiene.



Forum Vice Chair

Rima F. Khabbaz, M.D., is the director of the National Center for Emerging and Zoonotic Infectious Diseases (NCEZID) at the U.S. Centers for Disease Control and Prevention (CDC). From 2010 to 2017, she was CDC's deputy director for infectious diseases and director of the Office of Infectious Diseases, where she helped lead the efforts of CDC's infectious disease national centers and advance the Agency's crosscutting infectious disease priorities including the integration of advanced

molecular detection technologies into public health. During that time, she also served on an interim basis as acting director of the National Center for Immunization and Respiratory Diseases, acting director of the National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, and acting director of NCEZID during leadership transitions. Her previous CDC positions include director of the National Center for Preparedness, Detection, and Control of Infectious Diseases; director, acting director, and associate director for epidemiologic science in the National Center for Infectious Diseases (NCID); and deputy director and associate director for science in the Division of Viral and Rickettsial Diseases. Her first job at CDC was an Epidemic Intelligence Service Officer in NCID's Hospital Infections Program. She later served as a medical epidemiologist in NCID's Retrovirus Diseases Branch, where she made major contributions to defining the epidemiology of the non-HIV retroviruses, specifically human T lymphotropic viruses (HTLV) I and II, in the United States and to developing guidance for counseling HTLV-infected persons. Following the hantavirus pulmonary syndrome outbreak in the southwestern United States in 1993, she led CDC's efforts to set up national surveillance for this syndrome. She also played a key role in developing and coordinating CDC's blood safety and food safety programs related to viral diseases. She has served in leadership positions during many of CDC's responses to outbreaks of new and/or reemerging infections, including Nipah, Ebola, West Nile virus, SARS, and monkeypox, and she led the CDC field team to the nation's capital during the public health response to the anthrax attacks of 2001. Dr. Khabbaz is a graduate of the American University of Beirut in Lebanon, where she obtained both her bachelor's degree in science (biology/chemistry) and her medical doctorate degree. She trained in internal medicine and completed a fellowship in infectious diseases at the University of Maryland in Baltimore. In addition to her CDC position, she serves as clinical adjunct professor of medicine (infectious diseases) at Emory University. Dr. Khabbaz is a fellow of the Infectious Diseases Society of America (IDSA), a member of the American Epidemiological Society, and a member of the American Society for Microbiology and of the American Society for Tropical Medicine and Hygiene. She is a graduate of the Public Health Leadership Institute at the University of North Carolina and the National Preparedness Leadership Initiative at Harvard University. She served on IDSA's Annual Meeting Scientific Program Committee and serves on the society's Public Health Committee. She also is a member of the National Academies of Sciences, Engineering, and Medicine's Forum on Microbial Threats.

Kevin Anderson, Ph.D., serves as a senior program manager in the Department of Homeland Security's (DHS's) Science and Technology Directorate, providing oversight and requirements for biodetection and biodiagnostics systems development for government-wide customers and stakeholders. Since joining DHS in 2003, Dr. Anderson has provided leadership for science program development, laboratory design, and strategic planning; served as a subject matter expert and advisor to the Bioterrorism Risk Assessment and Biological Threat Characterization programs; and has participated in interagency working groups and assessments which provide guidance to medical countermeasure development, a key component of the nation's biodefense strategy. Prior to joining DHS, Dr. Anderson was a principal investigator at the U.S. Army Medical Research Institute of Infectious Diseases, leading research focused on understanding basic mechanisms of viral diseases causing hemorrhagic fever and development of medical countermeasures. He received postdoctoral training in molecular virology at the University of Alabama at Birmingham and the University of North Carolina at Chapel Hill, performing basic research on human respiratory syncytial viruses, and earned Ph.D. and B.S. degrees in microbiology from Montana State University and the University of Maryland, College Park, respectively.



Timothy Burgess, M.D., is Director of the Infectious Diseases Clinical Research Program at Uniformed Services University. He is a graduate of the U. S. Naval Academy and the Indiana University School of Medicine. He trained in Internal Medicine and Infectious Diseases at National Naval Medical Center and Walter Reed Army Medical Center, and completed a Master of Public Health degree as well as a Certificate in Tropical Medicine and Travelers' Health at the Uniformed Services University. His research has included immunopathogenesis and epidemiology of dengue hemorrhagic fever, chikungunya and influenza. He currently oversees a portfolio of clinical observational and interventional studies in the areas of acute respiratory infections, skin and soft tissue infections, trauma-related infections, HIV disease, vector-borne disease and acute enteric infections. He has served as investigator and department head at the Naval Medical Research Center in Silver Spring, MD, and at Naval Medical Research Unit #2 in Jakarta; as director of basic research for the US Military's dengue vaccine development program; and as Chief of the Infectious Diseases Clinical Service at Walter Reed National Military Medical Center, Bethesda. He is a member of the faculty in the Departments of Preventive Medicine & Biostatistics and Medicine, and the Emerging Infectious Diseases interdisciplinary program, at the F. Edward Hébert School of Medicine, Uniformed Services University.

Attending the meeting with the Standing Committee for Dr. Burgess is:

Bernard Okech, Ph.D., M.S., M.P.H., is a public health entomologist with extensive research and teaching experience in mosquito borne disease transmission. He has come to USU as the deputy director of the MPH program. Prior to joining USU, Dr. Okech was a Research Associate Professor of Environmental and Global Health and also research faculty at the Emerging Pathogens Institute at the University of Florida for more than 12 years. His research is focused on the influence of host and environmental factors on vector borne disease transmission, particularly in developing country environments. Dr. Okech's research program has been supported by funding from the DoD, NIH, USDA, USAID amongst others. Dr. Okech collaborates closely with researchers across the spectrum from local and international universities, US military, USAID, CDC, and Ministry of Health agencies in several in developing countries. These collaborations were particularly useful during the Chikungunya and Zika virus outbreaks that swept the western hemisphere in 2014/2016. During these outbreaks, Dr. Okech's team uncovered novel pathogens in mosquitoes while also providing information about future potential disease outbreaks in the population. Dr. Okech holds a Master of Science from University of Nairobi,

Doctor of Philosophy from Kenyatta University and Master of Public Health degree from University of California Berkeley.



Marcos A. Espinal, M.D., Dr.P.H., M.P.H., is the director of the Department of Communicable Diseases and Health Analysis at the Pan American Health Organization (PAHO), Regional Office of the World Health Organization (WHO) for the Americas. Dr. Espinal, a national of the Dominican Republic, holds a medical degree from the Universidad Autónoma de Santo Domingo, Dominican Republic (1985). He has an M.P.H. (1990) and a Dr.P.H. (1995) from the University of California at Berkeley School of Public Health. His work experience includes positions in the Ministry of Health of the Dominican Republic and the National Center for Research on Maternal and Child Health; the New York City Public Health Department; and the WHO where he worked for 13 years. Before joining PAHO, Dr. Espinal served as Executive Secretary of the WHO Stop TB Partnership, a global movement aiming at the elimination of TB as a public health problem. Dr. Espinal has published more than 100 peer-reviewed publications in the field of communicable diseases. He is a recipient of the Scientific Prize of the International Union against Tuberculosis and Lung Diseases, the Walter and Elise A. Hass International Award by the University of California at Berkeley for a distinguished record of service in international health, and the Princess Chichibu Memorial Tuberculosis Global Award by the Japan Anti-Tuberculosis Association.



Eva Harris, Ph.D., is a professor in the Division of Infectious Diseases in the School of Public Health and Director of the Center for Global Public Health at the University of California, Berkeley. She has developed a multidisciplinary approach to study the molecular virology, pathogenesis, immunology, epidemiology, clinical aspects, and control of dengue, Zika, and chikungunya, the most prevalent mosquito-borne viral diseases in humans. Specifically, her work addresses immune correlates of protection and pathogenesis, viral and host factors that modulate disease severity, and virus replication and evolution, using in vitro approaches, animal models, and research involving human populations. This has been possible through a close collaboration with the Ministry of Health in Nicaragua for over 28 years. Her international work focuses on laboratory-based and epidemiological studies of dengue, chikungunya, Zika, and influenza in endemic Latin American countries, particularly in Nicaragua, where ongoing projects include clinical and biological studies of severe dengue, a pediatric cohort study of dengue, Zika, chikungunya, and influenza transmission in Managua, a household transmission study of Zika, and a recently concluded cluster-randomized controlled trial of evidence-based, community-derived interventions for prevention of dengue via control of its mosquito vector. She is also directing a study of Zika in infants and pregnancy in Nicaragua and evaluating a number of Zika diagnostic tests with her team in Nicaragua. In 1997, she received a MacArthur Award for work over the previous 10 years developing programs to build scientific capacity in developing countries to address public health and infectious disease issues. This enabled her to found a nonprofit organization in 1998, Sustainable Sciences Institute (SSI; www.sustainablesciences.org), with offices in San Francisco, Nicaragua, and Egypt, to continue and expand this work. Dr. Harris was named a Pew Scholar for her work on dengue pathogenesis. She received a national recognition award from the Minister of Health of Nicaragua for her contribution to scientific development and was selected as a “Global Leader for Tomorrow” by the World Economic Forum. In 2012, she was elected Councilor of the American Society of Tropical Medicine and Hygiene and received a Global Citizen Award from the United Nations Association. She has published over 200 peer-reviewed articles, as well as a book on her international scientific work.



Elizabeth D. Hermesen, Pharm.D., M.B.A., is the head of Global Antimicrobial Stewardship at Merck & Co., Inc. and an adjunct associate professor at the University of Nebraska Medical Center, Colleges of Pharmacy and Medicine, in Omaha, Nebraska. Dr. Hermesen received her Doctor of Pharmacy degree from the University of Nebraska Medical Center followed by a pharmacy practice residency at The Nebraska Medical Center, a fellowship in infectious diseases research at the University of Minnesota College of Pharmacy, and a master's degree in business administration at the

University of Minnesota Carlson School of Management with an emphasis in health care industry. Following her fellowship, Dr. Hermesen developed and codirected the antimicrobial stewardship program at The Nebraska Medical Center and subsequently joined Cubist, where she created and led the Antimicrobial Stewardship Outreach Group. Now, in her role at Merck, she is responsible for creating and executing a strategy to advance antimicrobial stewardship through education, implementation, research, and advocacy focused on patient outcomes, population health, and the value of care. When leading the program at The Nebraska Medical Center, Dr. Hermesen developed a publicly-available antimicrobial stewardship website (www.nebraskamed.com/asp) that subsequently was featured in an article regarding top web resources for antimicrobial stewardship (Pagani L, et al. Navigating the Web in Search of Resources on Antimicrobial Stewardship in Health Care Institutions. *Clin Infect Dis*. 2009; 48:626-32.). Dr. Hermesen actively contributed to the advancement of the Society of Infectious Diseases Pharmacists (SIDP) Antimicrobial Stewardship Certificate Program during her term as SIDP president and continues to participate as a lecturer in the program. Dr. Hermesen served as a contributing member of the Antimicrobial Stewardship Knowledge & Skills Collaborative, coordinated by the Society for Healthcare Epidemiology of America; an expert panel on Antimicrobial Practice Improvement in Hospitals, coordinated by the American Society of Health-System Pharmacists; an expert panel on Hospital-based Antimicrobial Utilization Surveillance via the National Healthcare Safety Network, coordinated by the U.S. Centers for Disease Control and Prevention (CDC); the Cardinal Health Infectious Diseases Advisory Group; and an expert panel coordinated by the National Quality Forum and CDC to develop the practical tool entitled, *Antibiotic Stewardship in Acute Care: A Practical Playbook*. Dr. Hermesen is currently co-chair of the Antimicrobial Stewardship Work Package (1A) for the Innovative Medicines Institute Driving Reinvestment in Research & Development and Responsible Antibiotic Use (DRIVE-AB) initiative (www.drive-ab.eu). Dr. Hermesen is a Board Certified Pharmacotherapy Specialist with added qualifications in infectious diseases. She has contributed to the profession with numerous publications in peer-reviewed journals, book contributions, and by serving as a reviewer for several professional journals. Dr. Hermesen has also given over 100 invited presentations at state, regional, national, and international meetings.

Christopher R. Houchens, Ph.D. is the Director of the Division of Chemical, Biological, Radiological and Nuclear Countermeasures within the Biomedical Advanced Research and Development Authority (BARDA), a component of the Office of the Assistant Secretary for Preparedness and Response in the U.S. Department of Health and Human Services. His primary role is building and managing a diverse product portfolio focused on the advanced research, development and procurement of novel vaccines, prophylactics, therapeutics, diagnostics and devices as medical countermeasures against chemical, biological, radiological and nuclear threats. In this role, Dr. Houchens conducts outreach with industry to identify new partnership opportunities and participates in numerous interagency working groups across the US government with the goal of strengthening the ability and capacity of the United States to rapidly respond to naturally occurring and intentionally engineered threats to public health. Dr. Houchens received his Ph.D. in Cell and Molecular Biology from the University of Vermont and continued his training as a Research Fellow at Johns Hopkins Medical Institute and a Staff Scientist at Memorial Sloan-

Kettering Cancer Center. Prior to joining BARDA, Dr. Houchens served as a Senior Scientist at the Defense Advanced Research Projects Agency where he managed translational research and development programs to rapidly design, manufacture and evaluate novel medical countermeasures. Dr. Houchens has over 25 years of experience ranging from early stage disease research to late stage product development and approval which has provided him a thorough understanding of the lifecycle of drug development and the challenges associated with each specific phase of product development.

Michael Mair, M.P.H., serves as the acting assistant commissioner for counterterrorism policy and acting director of the Office of Counterterrorism and Emerging Threats in the Office of the Chief Scientist, U.S. Food and Drug Administration (FDA). In this capacity, Mr. Mair is responsible for providing leadership, coordination, and oversight for FDA's national and global health security and emerging threat portfolios. Mr. Mair also coordinates FDA's Medical Countermeasures Initiative (MCMi), a key component of a broad U.S. government program to improve the U.S. capacity to prepare for and respond to public health emergencies.



Jonna A. K. Mazet, D.V.M., M.P.V.M., Ph.D., earned her doctorate of veterinary medicine, master of preventative medicine, and her Ph.D. in epidemiology from the University of California, Davis. In addition to her faculty appointment in the Department of Medicine and Epidemiology in the UC Davis School of Veterinary Medicine, she serves as the Executive Director of the UC Davis One Health Institute (OHI). Dr. Mazet specializes in emerging infectious diseases and wildlife epidemiology, and as director of OHI, focuses on global health problem solving. In

her role at UC Davis, she assists government agencies and the public with emerging health challenges, and is active in international One Health research programs such as tuberculosis in Africa, novel pathogen detection in less developed countries, and pathogen pollution of California coastal waters. Dr. Mazet founded California's Oiled Wildlife Care Network, the premier model wildlife emergency management system worldwide, and remains a consulting expert on wildlife emergency preparedness and response, serving on multiple government and nongovernment organization advisory panels. Dr. Mazet is the principal investigator and global director of the novel viral emergence early warning project, PREDICT, that has been developed with the USAID's Emerging Pandemic Threats Program. She leads a network of global NGOs and governmental agencies to build capacity within the PREDICT-engaged countries to develop surveillance systems and complete the necessary research to halt the next pandemic, like influenza, SARS, Ebola, and HIV that have preceded the program.

Sally A. Miller, Ph.D., is a professor of plant pathology and state extension specialist for vegetable pathology at The Ohio State University, Ohio Agricultural Research and Development Center in Wooster, Ohio. She received her B. Sc. in biology from The Ohio State University (OSU), and M.S. and Ph.D. degrees in plant pathology from the University of Wisconsin-Madison. Prior to joining The Ohio State University faculty in 1991, she was a research manager at Agri-Diagnostics Associates in Cinnaminson, New Jersey, an early developer of plant disease diagnostic assays. Dr. Miller's research is focused on the development of sustainable disease management strategies for conventional and organic vegetable crops, in open field and protected (greenhouse and high tunnel) production systems. This includes diagnosis and management of diseases caused by viruses, bacteria, fungi, oomycetes (water molds), and nematodes. Her lab diagnoses more than 300 vegetable samples from growers and home gardeners each year, at no cost to Ohio residents. Areas of research emphasis are bacterial disease management in processing, fresh market and hydroponic tomatoes, downy mildew and bacterial wilt in cucurbits, soilborne diseases in all vegetable



crops, and food safety. Outreach efforts are directed primarily to vegetable growers and extension educators, and in addition to diagnostics include providing management advice through presentations, fact sheets and other printed information, and social media (websites, blogs, and Twitter). Dr. Miller has been active in long-term international agricultural development projects on integrated pest management (IPM) and plant diagnostics in South and Southeast Asia, Ukraine, West and East Africa, and Central America, primarily under the auspices of the U.S. Agency for International Development (USAID). Current USAID-funded IPM programs are underway in East Africa (Tanzania, Kenya, and Ethiopia) and South/Southeast Asia (Bangladesh, Nepal, and Cambodia). Dr. Miller has been active in the leadership of the American Phytopathological Society, serving as president in 2015-2016. She has recently been appointed to a Food and Agriculture Organization of the United Nations expert panel on antimicrobial resistance, and serves on the executive committee and two working groups for OSU's Global One Health Initiative.



Suerie Moon, Ph.D., M.P.A., is director of research at the Global Health Centre, Graduate Institute of International and Development Studies, Geneva and adjunct lecturer on global health at the Harvard T.H. Chan School of Public Health. She has served on a number of advisory bodies, including most recently the World Health Organization Fair Pricing Forum Advisory Group, Expert Advisory Group to the United Nations Secretary General's High-Level Panel on Access to Medicines, and Proposal Review Committee of UNITAID. Prior to joining the Graduate Institute,

she was study director of the Harvard-London School of Hygiene & Tropical Medicine Independent Panel on the Global Response to Ebola, and cofounded and led the Forum on Global Governance for Health, a focal point at Harvard University for research, debate, and strategic convening on issues at the intersection of global governance and health. Her research and teaching focus on global governance, the political economy of global health (focusing on innovation and access to medicines; outbreak preparedness and response; trade, investment, and intellectual property rules; and development assistance for health), the evolution of international regimes, and innovative policies for addressing global problems. She received a B.A. from Yale, an M.P.A. from Princeton, and a Ph.D. from the Harvard Kennedy School of Government.



Rafael Obregon, Ph.D., M.A., provides technical leadership and guidance on the development of standards, guidelines, and quality assurance for the application of communication for development principles and strategies across programmatic areas of the United Nations Children's Fund (UNICEF), including emergency response and humanitarian action. In this capacity, Dr. Obregon has engaged in several responses to public health emergencies and disease outbreaks, including the 2014 – 2015 West Africa Ebola Outbreak. In 2016 Dr. Obregon also served as a

member of the Advisory Committee to the World Health Organization's (WHO's) International Health Regulations Emergency Committee on Zika virus and observed increase in neurological disorders and neonatal malformations. Prior to joining UNICEF, he has served as regional advisor for health communication within the Area of Family and Community Health and Child and Adolescent Health Unit at the Pan American Health Organization. Dr Obregon has also been a technical advisor, researcher, and resource/focal person for international/national cooperation agencies and government and nongovernmental organizations, particularly in health and development initiatives. His duties have focused on formative research, project design and evaluation, and capacity strengthening. Dr. Obregon has also been associate professor and guest faculty member at a number of universities, including Ohio University, the Universidad Autónoma in Barcelona, Spain, and the Universidad del Norte in Barranquilla, Colombia, where he remains as an adjunct faculty. Throughout his career, he has written

several books, book chapters, monographs, manuals, peer-reviewed journal articles and reports on public health communication, participatory communication, and capacity development. He is a member of several editorial boards including the *Journal of Health Communication*, and has been a member of several scientific committees including the World Congress on Communication and Development, convened by the World Bank, the Food and Agriculture Organization of the United Nations, and the Communication Initiative, as well as a member of the Technical Advisory Group for the Global Health Communication Partnership within the Center for Communication Programs at Johns Hopkins University. Dr. Obregon earned his Ph.D. in an interdisciplinary program in mass communications, with a concentration on international health, at the College of Communications at Pennsylvania State University in 1999. He received his Master of Arts in international affairs and communication and development from Ohio University in 1994 with a minor in public health. Additionally, he obtained a diploma in education and pedagogy through the National Apprenticeship Service in Colombia in 1990.

Kumanan Rasanathan, M.B.Ch.B., M.P.H., a public health physician with 20 years of experience in health and related sectors. He is a member of the board of Health Systems Global and currently works in the areas of health systems and maternal and child health in Cambodia. He was previously chief, Implementation Research Unit and Delivery Science Unit and Senior Adviser Health for United Nations Children's Fund in New York, working on implementation research focused on improving child service delivery, universal health coverage, district health system strengthening, health systems resilience post-Ebola, integrated community case management, the Sustainable Development Goals agenda, and multisectoral approaches to child health. Prior to this, Dr. Rasanathan worked for the World Health Organization in Geneva on primary health care and the social determinants of health, and in a number of different countries as a clinician, researcher, policy maker, program manager, and advocate. He started his public health career running Phase I and II vaccine clinical trials leading to the licensure and rollout of meningococcal B vaccine in New Zealand.



Gary A. Roselle, M.D., is the national director, Infectious Diseases Service for the Veterans Health Administration of the Department of Veterans Affairs (VA). Dr. Roselle is board certified in internal medicine and infectious diseases and a professor of medicine in the Department of Internal Medicine, Division of Infectious Diseases at the University of Cincinnati College of Medicine. Dr. Roselle serves on multiple national VA and Federal Interagency Committees. He serves as the VA representative on the U.S. Centers for Disease Control and Prevention's (CDC's) Advisory Council for the Elimination of Tuberculosis, CDC's Public Health Action Plan to Combat Antimicrobial Resistance Task Force, CDC's Healthcare Infection Control Practices Advisory Committee, and the Department of Health and Human Services' Steering Committee for the Prevention of Healthcare-Associated Infections, and the National Academies of Sciences, Engineering, and Medicine's Forum on Microbial Threats.

Peter A. Sands, M.P.A., is the executive director of The Global Fund to Fight AIDS, Tuberculosis, and Malaria. Since June 2015, Mr. Sands has been a research fellow at Harvard University, dividing his time between the Mossavar-Rahmani Center for Business and Government at Harvard Kennedy School and the Harvard Global Health Institute, part of the Harvard T.H. Chan School of Public Health, and working on a range of research projects in financial markets and regulation, fintech, and global health. Mr. Sands' engagement with global health issues includes: chairing the U.S. National Academy of Medicine's Commission on a Global Health Risk



Framework for the Future, which in January 2016 produced the highly influential report *The Neglected Dimension of Global Security: A Framework to Counter Infectious Disease Threats*; chairing the World Bank's International Working Group on financing preparedness, which in May 2017 published *From Panic and Neglect to Investing in Health Security: Financing Preparedness at a National Level*; authoring several papers on infectious disease crises in the *New England Journal of Medicine*, *The Lancet*, and *British Medical Journal*; being the lead non-executive director between 2011-2017 on the Board of the UK's Department of Health, which provides oversight and policy direction to the UK's National Health Service; and being an active member on both the U.S. National Academy of Science's Committee on Ensuring Access to Affordable Drugs and the Forum on Microbial Threats. Mr. Sands is a board member or advisor to several startups in the fintech and meditech arenas, such as Noble Markets (US) and Cera (UK). He was group chief executive of Standard Chartered PLC from November 2006 to June 2015. He joined the Board of Standard Chartered PLC as group finance director in May 2002, responsible for finance, strategy, risk and technology, and operations. Prior to this, Mr. Sands was a senior partner at worldwide consultants McKinsey & Co. Before joining McKinsey, he worked for the UK's Foreign and Commonwealth Office. He has served on various boards and commissions, including as a director of the World Economic Forum and co-chairman of Davos, governor of the UK's National Institute for Economic and Social Research, member of the International Advisory Board of the Monetary Authority of Singapore, member of the Browne Commission on Higher Education Funding in the UK, member of the China People's Association for Friendship with Foreign People's Global CEO Council, co-chair of the UK-India CEO Forum, board director of the Institute of International Finance, chairman of the International Monetary Conference, member of the International Advisory Board of Lingnan University, China, and trustee of the Camden Roundhouse, London. Mr. Sands graduated from Brasenose College, Oxford University with a first class degree in politics, philosophy, and economics. He also received a Master in Public Administration from Harvard University, where he was a Harkness Fellow. Mr. Sands, who grew up in Singapore and Malaysia, is married to author and bookshop owner, Betsy Tobin and has four children.



Thomas W. Scott, Ph.D., is a distinguished professor of mosquito-transmitted disease ecology and epidemiology at the University of California, Davis. He received his Ph.D. in ecology from the Pennsylvania State University and was a postdoctoral fellow in epidemiology at the Yale School of Medicine. After initially examining the relationship of mosquito ecology to pathogen transmission in Southeast Asia, Latin America, and Africa in the early 1990s, in an effort to strengthen the public health connection of his work, he began longitudinal dengue epidemiological studies in Thailand and Peru. He currently focuses on assessment of recommendations for mosquito-borne disease prevention, testing assumptions in public health policy, and developing innovative, cost-, and operationally-effective concepts for disease prevention. At UC Davis, he was director of the Center for Vector-Borne Disease Research and the Davis Arbovirus Research Unit. He chaired the Mosquito-Borne Disease Working Group in the Research and Policy in Infectious Disease Dynamics (RAPIDD) program, which developed novel mathematical modeling frameworks and reported to the Science and Technology Directorate of the Department of Homeland Security, and Fogarty International Center at the National Institutes of Health. At the World Health Organization, he chairs the Vector Control Advisory Group, which assesses the public health value of new product classes in vector control; has co-chaired the Global Vector Control Response, which aims to reduce the global burden of vector-borne diseases through locally adapted sustainable vector control; chaired the Emergency Response Consultation for Zika Virus; and serves on the International Health Regulators Roster of Experts. He is a member of the Management Committee for the Global Dengue and Aedes-transmitted Diseases Consortium.

Alan Tennenberg, M.D., M.P.H., is the Chief Medical Officer of Johnson & Johnson Global Public Health. Trained as an infectious diseases physician, Alan brings over 25 years of experience in the pharmaceutical industry, clinical medicine, public health, and academia. As Chief Medical Officer, he is responsible for building strategic relationships with key stakeholders and partners in government, academia, multi-lateral institutions, and non-governmental organizations around the world. He is a leading figure in facilitating private sector engagement to advance the Global Health Security Agenda.



Matthew Zahn, M.D., currently serves as medical director of the Division of Epidemiology and Assessment for the Orange County Health Care Agency. Dr. Zahn received his doctorate in medicine from St. Louis University School of Medicine. From 2004 through 2011, he served as medical director for the Louisville Metro Department of Public Health and Wellness. During that time, he also served as an assistant professor of pediatric infectious disease at the University of Louisville School of Medicine. Dr. Zahn has served on multiple national public health committees, including his current service as the chair of the Infectious Diseases Society of America's Public Health Workgroup.



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Biographies

Ann E. Kurth, Ph.D., CNM, M.P.H., FAAN is Dean, and Linda Koch Lorimer Professor, Yale University School of Nursing. Dr. Kurth is an elected Fellow of the Institute of Medicine (National Academy of Medicine) and a member of the 2014-2018 US Preventive Services Task Force, which sets screening and primary care prevention guidelines for the United States. Dr. Kurth is 2018-2020 chair of the Consortium of Universities for Global Health. An epidemiologist and clinically-trained nurse-midwife, Dr. Kurth's research focuses on HIV/reproductive health and global health system strengthening. Her work has been funded by the National Institutes of Health (NIAID, NIDA, NIMH, NICHD), the Bill & Melinda Gates Foundation, UNAIDS, CDC, HRSA, and others, for studies conducted in the United States and internationally. Dr. Kurth has consulted for the NIH, Gates Foundation, WHO, USAID and CDC, among others. Dr. Kurth has published over 200 peer-reviewed articles, book chapters, and scholarly monographs and presented at hundreds of scientific conferences and invited talks. Dr. Kurth has received awards for her science and leadership including the Friends of the National Institute of Nursing Research Ada Sue Hinshaw Research Award and the International Nurse Researcher Hall of Fame award from Sigma Theta Tau International.

Kelly Baker, Ph.D. is an Assistant Professor in Occupational and Environmental Health, and Epidemiology at the University of Iowa's College of Public Health, and is a faculty member of the interdisciplinary Sustainable Water Development Program in the College of Engineering. Her research focuses on understanding how unsafe water, sanitation and hygiene (WASH) conditions affect maternal and child health outcomes in low and middle income countries. Her Social Microbes program uses an microbial ecology systems approach to understand the complex behavioral, environmental, and spatial-temporal mechanisms that result in young children being exposed to and infected by dozens of types of common enteric pathogens in unsanitary settings. A fundamental theory underlying this research is that in highly unsanitary settings where multiple types of enteric pathogens are dynamically transmitted between humans and animal populations over space and time, the distribution of transmission risks are characterized at the simplest level by presence and concentration of a specific pathogen and at the most complex level by simultaneous exposure to multiple types of pathogens. Dr. Baker's group uses microbial exposure assessment and epidemiology approaches to identify and rank priority transmission pathways, as well as to evaluate the impact of WASH intervention trials. Other research in the Baker Group focuses on documenting how social and environmental barriers in meeting daily WASH needs affects women's reproductive health, with a particular focus on the epidemiology of preterm birth and low infant birth weight outcomes in pregnant women. Dr. Baker has advised the World Bank, World Health Organization, UNICEF and several NGOs on issues related to water quality, priority enteric pathogens, and infectious disease exposure assessment and epidemiology.

Michele Barry, M.D., is Senior Associate Dean for Global Health and Director of the Center for Innovation in Global Health at Stanford University. She is a past President of The American Society of Tropical Medicine and Hygiene and has also served on the advisory board of NIH -Fogarty Center. Areas of scholarly interest include global health workforce, clinical tropical medicine, emerging infectious

diseases, problems of underserved populations and globalization's impact upon health in the developing world. Dr. Barry is an elected member of the National Academy of Medicine.

Sarah Cleaveland, Ph.D., is a Professor of Comparative Epidemiology at the University of Glasgow, UK Institute of Biodiversity, Animal Health and Comparative Medicine. She is a veterinary epidemiologist and leads a research program investigating zoonotic and livestock diseases in Africa. Her research focuses on understanding the burden, epidemiology and control of zoonoses and has generated evidence to support the feasibility of canine rabies elimination. Professor Cleaveland is a member of the National Academy of Medicine.

Malick Diara, M.D., M.B.A., M.P.H., joined ExxonMobil in 2009 with more than 20 years of experience in international health. He is the Public Health Manager of the Exxon Mobil Corporate Medicine and Occupational Health (MOH) Department. As a member of the MOH leadership team, his responsibilities are focused on infectious disease prevention and control in ExxonMobil workplaces, and recently, on management oversight of the Company Culture of Health Program. His illustrative accomplishments include the successful establishment of the Company infectious disease outbreak management program with no operation disruption since 2010, no death due to malaria for the past 10 years with the development of a malaria drug field test that saved over 1.6 USD million within 3 years on lab costs and the launch of a global Tuberculosis control program with over 1000 TB cases averted since 2010. Prior to ExxonMobil and being based in Houston since 2009, Dr. Diara worked with private Non Profit organizations in Washington DC for 9 years and in West Africa for 12 years. With funding from USAID, the French Cooperation or the European Union, and in partnership with local authorities and organizations such as UNICEF and WHO, he supported the design, implementation and evaluation of global, national or local public health programs. Malick is a physician with a Medical Doctorate from Dakar School of Medicine in Senegal, a Master's in Business Administration from the Paris School of Business – Institut Supérieur de Gestion and a Masters in Public Health from Tulane University, Louisiana.

Isabel Garcia, D.D.S., M.P.H., joined the University of Florida College of Dentistry as dean on Feb. 16, 2015, after retiring from the U.S. Public Health Service in 2014 as a rear admiral lower half. Garcia's career spans 37 years in public health, clinical practice, research, teaching and administration at the local, state and national levels. Garcia joined the National Institute of Dental and Craniofacial Research at the NIH in 1995 and held multiple leadership roles during her time there. She led NIDCR's science transfer efforts, directed the Institute's Office of Science Policy and Analysis, and served as acting NIDCR director from 2010-2011. Garcia also served as the institute's coordinator for global health and directed NIDCR's Residency in Dental Public Health program from 2005 to 2014. While with the USPHS, Garcia was deployed to help prepare a major health diplomacy mission to Central and South America, which provided care to over 85,000 people in 12 countries.

As deputy director of NIDCR from 2007-2014, she shared responsibility for the oversight and management of programs and functions within the institute — which included a staff of more than 400 scientists and administrators dedicated to research, training, science policy, health education, communications and financial management. Garcia received a doctorate in dental surgery in 1980 from Virginia Commonwealth University and a master's degree in public health from the University of Michigan in 1988. She subsequently completed a residency in dental public health at the University of Michigan and a fellowship in primary care policy from the U.S. Public Health Service. A fellow of the American College of Dentists and the Pierre Fauchard Academy, Dr. Garcia is a diplomate and Past President of the American Board of Dental Public Health and an active member of the American Dental Education Association, the International Association for Dental Research, and the American Dental Association.

Lawrence Gostin, J.D., is University Professor (Georgetown University's highest academic rank) and the Founding Linda and Timothy O'Neill Professor of Global Health Law at Georgetown University, Professor of Public Health at Johns Hopkins University, Director of the O'Neill Institute on National and Global Law, and Director of the WHO Collaborating Center on Public Health Law and Human Rights at the Georgetown University Law Center. He is a global correspondent and contributing writer for JAMA, the journal of the American Medical Association. In 2016, President Obama appointed him to a six-year term on the National Cancer Advisory Board.

Andrew Kanter, M.D., M.P.H., FACMI, is Assistant Professor of Clinical Biomedical Informatics and Clinical Epidemiology at Columbia University. Interested in application of ICT to health in the developing world, he has worked or traveled in more than 50 countries. Prior to joining Columbia, he recently spent 12 years with a private medical informatics company where he helped develop the Healthmatics EHR now being sold by Allscripts in addition to providing medical terminology and consulting services to other electronic medical record companies. He is currently appointed to Columbia University full-time in the Departments of Biomedical Informatics (College of Physicians & Surgeons) and Epidemiology (Mailman School of Public Health) and previously supported the development and implementation of the Millennium Villages Global-Network (MVG-Net) for the Millennium Villages Project (MVP). He directs the Columbia International eHealth Lab (CIEL) in the Department of Biomedical Informatics which supports eHealth work around the world. His work focuses on bringing real-world solutions to resource-poor settings to help them achieve the Millennium Development Goals.

Karestan Koenen, Ph.D., does research and teaches about trauma and posttraumatic stress disorder (PTSD). The broad goal of her work is three-fold. First, she studies why, when exposed to a similar traumatic event, some persons develop PTSD while others are resilient. She is particularly interested in how genes shape risk for PTSD. Much of this work is done through the PTSD working group of the Psychiatric Genomics Consortium that she co-leads with Kerry Ressler and Israel Liberzon. Second, she investigates how trauma and PTSD influence weight gain and alter long-term physical health including chronic diseases such as cardiovascular disease and type-2-diabetes. Third, she documents global burden of trauma and PTSD through her work with the World Mental Health Surveys. Dr. Koenen also advocates for victims of sexual violence. In May 2011, Dr. Koenen testified before the House Foreign Affairs Full Committee about the epidemic of sexual violence and victim blaming culture of the Peace Corps. She has written for the Boston Globe, the Washington Post, the Huffington Post, and the Women's Media Center's Women Under Siege Project, a journalism project founded by Gloria Steinem that investigates how rape and other forms of sexualized violence are used as tools in conflict. Dr. Koenen also consulted with award-winning documentary filmmaker Lisa Jackson on the film *It Happened Here*, which investigates the epidemic of sexual assault on university campuses. Dr. Koenen currently lives in Boston. When not working, she is likely taking a yoga class or spending time with her son, Lorcan.

Orin Levine, Ph.D., leads the foundation's efforts to accelerate the introduction of new vaccines and related technologies and to improve routine immunization systems. He is the Foundation's focal point for engagement with the GAVI Alliance whose mission is saving children's lives by increasing access to immunization in poor countries. Before joining the foundation's Global Development Program in 2012, Dr. Levine was a Professor of International Health, and Executive Director of the International Vaccine Access Center (IVAC) at the Johns Hopkins University's Bloomberg School of Public Health. He has also served as a Steering Committee Member of the Decade of Vaccines Collaboration and Co-Chair of its Global Access Working Group, as well as President, Committee on Global Health, American Society of

Tropical Medicine & Hygiene. Dr. Levine graduated with a Bachelor's degree from Gettysburg College and received a PhD in epidemiology from The Johns Hopkins Bloomberg School of Public Health.

Maureen Lichtveld, M.D., M.P.H., is Professor and Chair of Environmental Health Sciences in the School of Public Health and Tropical Medicine at Tulane University. Dr. Lichtveld's career in environmental public health spans more than 30 years. Her research focuses on environmentally induced diseases including asthma and cancer, health disparities, environmental health policy, disaster preparedness, and public health systems. Her global health expertise is focused on lower and middle income countries in the Caribbean, a region faced with recurring infectious disease epidemics, a significant NCD burden natural disasters, and unprecedented environmental health threats.

Gbenga Ogedegbe, M.D., M.P.H., M.S., a physician, is the Adolph & Margaret Berger Professor of Population Health & Medicine, Chief Division of Health & Behavior and Director Center for Healthful Behavior Change in the Department of Population Health at New York University School of Medicine. Gbenga is a leading expert on health disparities research; his work focuses on the implementation of evidence-based interventions for cardiovascular risk reduction in minority populations. He is Principal Investigator on numerous NIH projects, and has expanded his work globally to Sub-Saharan Africa where he is funded by the NIH to strengthen research capacity and reduce the burden of noncommunicable diseases. He has co-authored over 250 publications and his work has been recognized by receipt of several research and mentoring awards including the prestigious John M. Eisenberg Excellence in Mentorship Award from the Agency for Healthcare Research and Quality, and the Daniel Savage Science Award. He has served on numerous scientific panels including the NIH, CDC, World Health Organization, and the European Union Research Council. Prior to joining NYU, he was faculty at Cornell Weill Medical School and Columbia University College of Physicians and Surgeons.

Scott C. Ratzan, M.D., M.P.A., is Senior Fellow at the Mossavar-Rahmani Center for Business & Government at Harvard Kennedy School of Government. Dr. Ratzan has three decades of pioneering accomplishments in the U.S. and globally in health communication, health literacy and strategic diplomacy. He is the founding Editor-in-Chief of the Journal of Health Communication: International Perspectives. He has been engaged in multidisciplinary activities related to global health including as President of the ABInBev Foundation and Vice President of Global Health and Social Impact at ABInBev. Dr. Ratzan was at Johnson & Johnson for eleven years including as Vice President of Global Health at headquarters and also in Brussels as VP Government Affairs & Policy. Before his private sector engagement, he worked at the US Agency for International Development (USAID) in Washington DC, designing the framework for the Bureau of Global Health communication efforts. He launched his career in Boston spending a decade in academia as a professor and Founding Director of the Emerson-Tufts Masters Program in Health Communication. In addition to a number of publications in the global health field, he is the co-author of the definition of health literacy adopted by the US Government and incorporated in the Affordable Care Act. Recently, he has served as Co-Chair of the UN Secretary General's Every Woman Every Child Innovation Working Group, on the U.S. Centers for Disease Control and Prevention, Board of Scientific Counselors, Office of Infectious Disease and on the World Economic Forum Global Agenda Council on Well-Being and Mental Health. Dr. Ratzan has an M.D. from the University of Southern California, an M.P.A. from the Harvard Kennedy School, and an M.A. in Communication from Emerson College. His academic appointments include Adjunct Professor at Columbia University Mailman School of Public Health, Tufts University School of Medicine, and George Washington University School of Public Health.

Carlos del Rio, M.D., is a Distinguished Professor of Medicine in the Division of Infectious Diseases at Emory University School of Medicine and Executive Associate Dean for Emory at Grady. He is also

Professor of Global Health in the Department of Global Health and Professor of Epidemiology at the Rollins School of Public Health. He is also co-Director of the Emory Center for AIDS Research (CFAR) and co-PI of the Emory-CDC HIV Clinical Trials Unit and the Emory Vaccine and Treatment Evaluation Unit. Dr. del Rio is a native of Mexico where he attended medical school at Universidad La Salle, graduating in 1983. He did his Internal Medicine and Infectious Diseases residencies at Emory University. In 1989 he returned to Mexico where he was Executive Director of the National AIDS Council of Mexico (CONASIDA, the Federal agency of the Mexican Government responsible for AIDS Policy throughout Mexico), from 1992 through 1996. In November of 1996 he returned to Emory where he has been involved in patient care, teaching and research. Dr. del Rio was Chief of the Emory Medical Service at Grady Memorial Hospital from 2001 - 2009 and Chair of the Department of Global Health from 2009 - 2019. Dr. del Rio's research focuses on the early diagnosis, access to care, engagement in care, compliance with antiretrovirals and the prevention of HIV infection. He has worked for over a decade with hard-to-reach populations including substance users to improve outcomes of those infected with HIV and to prevent infection with those at risk. He is also interested in the translation of research findings into practice and policy. His international work includes collaborations in the country of Georgia, Ethiopia, Vietnam, Mexico, Kenya and Thailand. He has also worked on emerging infections such as pandemic influenza and was a member of the WHO Influenza A(H1N1) Clinical Advisory Group and of the CDC Influenza A(H1N1) Task Force during the 2009 pandemic. Dr. del Rio is a Member of the Board of Directors of the International Antiviral Society-USA (IAS-USA) and was a Board member and Chair of HIVMA of the Infectious Diseases Society of America (IDSA). He is also the Chair of the PEPFAR Scientific Advisory Board. He is Chief Section Editor for HIV/AIDS for NEJM Journal Watch Infectious Diseases, Associate Editor for Clinical Infectious Diseases and member of the editorial board of Journal of AIDS and Global Public Health. Dr. del Rio has co-authored 30 book chapters and over 350 scientific papers. Among his many honors are the James H. Nakano Citation received in 2001 and awarded by the CDC for an outstanding scientific paper published in 2000; the Emory University Marion V. Creekmore Achievement Award for Internationalization; he was selected by the "Atlanta Magazine" as one of the 55 most influential foreign born Atlantans in 2007. In 2013 Dr. del Rio was elected to the National Academy of Medicine and in 2020 was elected as Foreign Secretary of the National Academy of Medicine.

Sarah Tishkoff, Ph.D., M.Phil., is the David and Lyn Silfen University Professor in Genetics and Biology at the University of Pennsylvania, holding appointments in the School of Medicine and the School of Arts and Sciences. Dr. Tishkoff studies genomic and phenotypic variation in ethnically diverse Africans. Her research combines field work, laboratory research, and computational methods to examine African population history and how genetic variation can affect a wide range of practical issues – for example, why humans have different susceptibility to disease, how they metabolize drugs, and how they adapt through evolution. Dr. Tishkoff is a member of the National Academy of Sciences and a recipient of an NIH Pioneer Award, a David and Lucile Packard Career Award, a Burroughs/Wellcome Fund Career Award, and a Penn Integrates Knowledge (PIK) endowed chair. She is a member of the board of directors of the American Society of Human Genetics and is on the editorial boards at PLOS Genetics, Genome Research; Evolution, Medicine, and Public Health; G3 (Genes, Genomes, and Genetics). Her research is supported by grants from the National Institutes of Health and the National Science Foundation.



CONSENSUS STUDY PROPOSAL



CONSENSUS STUDY PROPOSAL

Emerging Infections: Global Health Security, Disease X, and the Future Pandemic Threat

The Institute of Medicine (IOM) first tackled the issue of microbial threats in their 1992 report *Emerging Infections: Microbial Threats to Health in the United States*. This report highlighted the need for a domestic response and preparedness capacity for new and emerging infectious diseases. Since that time, the global burden of infectious disease has increased, as have threats to the United States. The 2003 IOM report, *Microbial Threats to Health: Emergence, Detection, and Response*, written in the aftermath of the anthrax attacks in the United States, served as a successor to this report and called for improved surveillance, diagnostics, vaccines, antimicrobials and a global response capacity. However, in the 16 years since this report was published, the pandemic threat has continued to grow, and our surveillance, response and prevention strategy continues to be challenged. For example:

- Outbreaks of Ebola have increased in size and number, spilled beyond borders, and threatened regional health and security
- New diseases have emerged and rapidly spread globally, including the current 2019-nCoV, Middle East Respiratory Syndrome, H1N1 triple reassortant influenza, and Zika virus
- Vaccine-preventable diseases, measles in particular, have increased in multiple countries, and many, including the United States, may soon lose elimination status
- Outbreaks of old diseases, such as plague and cholera, have re-emerged in many countries
- Antibiotic-resistant pathogens have increased, and present one of the biggest threats to global health today

With each crisis, we learn new lessons, leading to new tactics to counter the pandemic threat:

- The World Health Organization created a senior management emergency response capacity
- The World Bank created the Pandemic Emergency Financing (PEF) Facility
- The Inter-Agency Standing Committee of the UN coordinates international organizations to provide humanitarian assistance during pandemics
- The Global Preparedness Monitoring Board (GPMB) was co-convened by the World Bank Group and the World Health Organization
- The African Centers for Disease Control was established
- The Coalition for Epidemic Preparedness Innovations was launched to expand the vaccine and therapeutics pipeline for new and rare infections
- National and regional networks have been established to build capacity to control and prevent emerging infections

Despite these initiatives, we are still in ‘catch-up’ mode in our fight against pandemics. The global response to outbreaks is often significant, but interest wanes between them, leaving preparedness

plans, vaccine and countermeasure development at the mercy of cyclical funding patterns. We face daunting microbial diversity in nature and, in our rapidly changing planet we have provided perfect conditions for new microbes to emerge. Megatrends of demographic and environmental changes, globalized travel and trade, and lack of health capacity characterize the most important disease hotspots. Our armory of vaccines and therapeutics is based on pathogens that have already emerged, and has failed to scale up in the face of a new pandemic. Finally, there is still no agreed-upon response strategy for a global pandemic. The GPMB's first annual report released in 2019 concluded that most countries have not implemented recommendations called for over previous years and identified seven urgent actions in country leadership, preparation, financial planning and international coordination.

The National Academies of Sciences, Engineering, and Medicine proposes to convene an expert committee to provide new recommendations on our strategy to deal with the complexity of emerging diseases. It will build upon recommendations from the previous IOM reports, expert committees that reviewed our global response to SARS, H1N1, MERS, and Ebola, and the global mandates expounded by the GPMB and the GHSA. The committee will identify key trends in the intervening years and what we can expect in the future, which recommendations have been implemented, and what the remaining gaps are. It will critically review the following initiatives, issues and megatrends that have emerged since the last report to identify which most effectively impact our national and global response:

- The role of One Health in preventing, detecting and responding to disease threats
- Evaluation of recently launched programs such as the
 - Global Health Security Agenda and Joint External Evaluations
 - New International Health Regulations
 - Sustainable Development Goals
 - Pandemic Emergency Financing Facility
- The impact of climate change and other global environmental changes on infectious disease transmission and outbreak risk, and mitigation strategies to deal with them
- Use of social media and big data in detecting and responding to pandemics
- The economic impact of outbreaks and economic incentives for preparedness
- Interactions of poverty, equity, and non-communicable diseases on EIDs, and how endemic and emerging disease programs can be leveraged more effectively
- Linkages between plant diseases, agriculture, food security and human infections
- Advances in our understanding of the ecology of microbes, the socio-economic and environmental drivers of disease emergence, and how this might be used to predict and prevent pandemics.

Most importantly, this report will, for the first time, bring together lessons from over 15 years of pandemic response to identify strategies in our fight against future pandemics. Disease pandemics are no longer just a health issue – they are emergencies that need an all of government response. They require international leadership, multilateral coordination, and public support on the frontline of outbreaks, and in the countries that support the response. In the age of Disease X, this report will provide a pathway towards preventing pandemics, and identify consensus strategies to break free from the cycle of pandemic emergence and response.